Gas Journal

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Editorial Notes

Removal of Sulphur Compounds

"WHATEVER may be the cost of removing carbon bisulphide from the benzole when we have recovered it, that cost expressed as so much per unit of gas treated is so small a price to pay for having a low sulphur gas that we should get on with the work anyhow." We are quoting from the oral reply of Mr. Hollings, necessarily brief, to the discussion on the Communication at the Research Meeting of The Institution of Gas Engineers on the removal of sulphur compounds from town gas. The Communication is outstanding; it typifies the Industry's new conception of research and the value of team work. Mr. Hollings was referring only to one, and we think a minor, aspect of this problem of supplying a gas as free as possible from contamination with compounds of sulphur. "We should get on with the work anyhow." This is what we have been saying for a long time, realizing that a sulphur-free gas—or at any rate a gas containing such a small content of sulphur compounds as in practical effect is negligible—means an enormous expansion of the gas heating load. As we write, a thick November fog and a temperature below freezing-point make the atmosphere outside forbidding to the stoutest constitution; but the Gas Industry, in a sulphur-free gas, has an effective counter to the vagaries even of the English climate. That measure of central heating so desirable as a background to cheerful radiant warmth would immediately become possible with a gas low in sulphur.

"We should get on with the work anyhow." It has taken a long time for our Industry to waken up to the fact that it ought to make a gas which, under carefully controlled and regulated conditions, can be burned flueless ly providing comfort at a cost cheaper than any other known means. "Sulphur must go." That, suggested Dr. Harold Hartley, of Radiation Ltd., years ago should be the slogan of the Gas Industry. Continually we have urged that this must not remain a mere slogan. The cost of removing sulphur is infinitesimal compared with the economic and prestige advantages which would demonstrably accompany its riddance. The incidence of this cost has been made clear as a result of what we consider a constructive and well-planned research directed with determination. At the Autumn Research Meeting of the Institution twelve months ago we were discussing ways and means of preparing a gas with a sulphur content as low as 10 grains per 100 cu.ft. Now we are thinking—as we should think—in terms of one or two grains per 100 cu.ft.; and this purely the consequence of teamwork research. Comparable with the work we are considering was the investigation carried out on the occurrence and formation of nitrogenous gum in gas—an investigation which, undertaken in spirit and letter as a team, provided a practical solution to district difficulties which were harassing and embarrassing scores of gas undertakings in the country.

Catalysis of chemical reactions is obviously destined to play a major rôle in the future progress of the Gas Industry, as also, of course, is the application of pressures above atmospheric. Actually, it was research into the catalytic elimination of nitric oxide from gas which led within a very short space of time into the discovery that organic sulphur compounds could simultaneously be removed by the one catalyst. The work in this regard communicated by Dr. Griffith at the Institution Research Meeting is of the greatest significance, and will, we think, modify present methods of gas treatment. At an early date we should consider the merits of the catalytic purification of gas on the lines described by Dr Griffith as a preliminary to the oil washing process as well as a preliminary to the active carbon process for the extraction of benzole. Gas treated in the manner he described contains no oxygen or nitric oxide, very small concentrations of carbon disulphide, mercaptans, or carbon oxysulphide, and a considerably lower percentage of diolefine hydrocarbons than it had originally. It should therefore be entirely free from troubles due to the formation of gummy deposits and should be capable of combustion in a flueless appliance with the formation only of traces of sulphur oxides.

The Catalytic Process

One of the chief virtues of the catalytic process is, perhaps, the fact that it is independent of benzole recovery from the gas. Installation of a catalytic unit prior to an oil washing plant appears, as we have said, to be indicated. Such a unit would render the benzole recovered by oil washing free from carbon bisulphide—an important consideration. "I have no doubt," said Mr. Claxton, of the National Benzole Company, during the discussion on the contribution by Messrs. Hollings and Hutchison and Dr. Griffith at the Institution Meeting, "that the Gas Industry is not very much interested in what becomes of the sulphur once it is taken out of the gas. From the benzole producers' point of view, however, sulphur is an unmitigated nuisance, and from this point of view the catalytic process has definite attractions." Again, and now we quote Dr. E. W. Smith in regard to the process. "If," he said, "it can be shown in the plant that is to be built to be economic . . . then there is no doubt it is an advantage to have a catalytic process which is independent of benzole washing, because we do not want to have the two tied up together unless it is essential." The advantages of a combination of the two types of plant, the catalytic unit for the removal of sulphur and nitric oxide and the oil washing plant, are apparent. During periods when washing for benzole was attractive economically or necessary for national welfare, then the units in combination would provide both a benzole to the liking of the distillers and a gas to the liking of the public. Should it, under certain conditions of the by-product markets, be economically undesirable to extract benzole, then the catalytic unit would continue to treat the gas so that it could be burned fluelessly to an extent which would be of the utmost benefit to the community and to the Gas Industry.

Without question, the research on gas catalysis which is the theme of Dr. Griffith's section of the Institution Communication under review reveals a fascinating view of the future possibilities of a more generally acceptable gas supply. The findings of the research necessarily appeal to the imagination; they are of immediate application. It would be a thousand pities, however, if in the scientific glamour of Dr. Griffith's work sight were lost of the genuine importance of the investigation into the oil washing process which is dealt with by Mr. Hutchison. In the active carbon process of benzole recovery about 75% of the total sulphur compounds in the gas are removed. Only about half this quantity of sulphur is removed in the normal oil washing process, and thought was given to the possibility of modifying oil washing plants. The outcome of Mr. Hutchison's work in this direction was the design of a new oil washing plant of formidable dimensions at the Kensal Green Works of the Gas Light and Coke Company. In this plant the thermal efficiency of the oil washing process has been improved by the adoption of improved heat exchange auxiliary plant and, at the same time, the advantage of distillation under reduced pressure has been realized. What we would emphasize is that these advantages in the oil washing process may be applied to the recovery of benzole quite independently of the removal of sulphur from gas. The introduction of the vacuum method of distillation has not been accompanied by any special difficulties in operation of the plant, and there would appear to be no reason why in smaller units semi-automatic control, as used in benzole plants of orthodox design, should not be employed. With the modifications described in his contribution to the Paper, Mr. Hutchison considers that a fair estimate of steam consumption would be 84 lb. in winter and 40 lb. in summer per gallon of benzole recovered when extracting 3·7 gallons per ton of coal, or 2·7 gallons per 10,000 cu.ft. of gas, and removing 75% of the sulphur from vertical gas or a rather higher proportion from gas from horizontal retorts. The point is that the results of Mr. Hutchison's work can be applied to existing oil washing practice.

We are in complete agreement with Mr. E. V. Evans in his remarks that the work of Mr. Hutchison in improving the oil washing process is an outstanding example of the advantages to be obtained when the facts are painstakingly analyzed by physical chemists and then reconstructed with knowledge and imagination.

Central Heating

Though some undertakings are going ahead with the gas central heating load it cannot be said that there is any general drive to cultivate this highly desirable field which offers such a remarkable sphere of expansion for gas business. There is, in fact, a great deal of inertia to be overcome within the Gas Industry itself. Too many hold the view that the load can be developed only by supplying gas at an exceedingly low price which, in view of the possible incidence of the load on extension of gas making plant, may in the outcome prove uneconomic. It is obvious, of course, that this type of business warrants a special form of pricing for the gas consumed. The offer of a domestic flat rate of, say, 9d. a therm will not cut any ice. On the other hand, there is no reason why the special price should be uneconomic. Most undertakings could afford to supply gas for this purpose at rates substantially below the ordinary flat rate, and supply this gas at a profit, for the central heating load gives high consumption at small maintenance costs, and must help to spread the "overheads." There is plenty of evidence to show that a vast amount of profitable business is to be gained in this field with gas at a price of about 5d. per therm; and there are many undertakings which can do sound trading at lower figures than this. The fact is that much more could be done to make our primary fuel available at economic prices for large heating loads.

It can generally be said that the advantages of gaseous fuel cannot be enjoyed at a lower cost than solid fuel; but these advantages are very real, and if proper emphasis is laid on the convenience, reliability, and cleanliness of gas many consumers will realize that these advantages are well worth paying for. This point, which we have emphasized before, was stressed by Mr. W. A. Bishop, of Croydon, in a closely reasoned Paper read before the Southern Association of Gas Engineers and Managers on Friday last. We have to sell a higher priced fuel against competing interests, and we have to sell up to a standard of perfect performance rather than down to a price. If we try to sell on price alone, we shall fail badly. And in putting forward propositions for central heating frankness and candour are imperative. It is bad business to understate the likely running cost; and except in especially favourable circumstances gas will cost more than solid fuel. On the other hand, the service which gas can give is far better than can be obtained from solid fuel, and this service is given automatically and with certainty. The difference in running costs has to be translated into the value of comfort and convenience, needing good salesmanship and courage to resolve the argument into actual installations. Costs should be given with adequate qualification, for so much depends upon methods

and periods of use, outside and inside temperatures, and so on, and it is most desirable to watch any installation very carefully during its initial period of use, so that any wastage or incorrect manipulation of the controls can be rectified before queries arise or mishandling of the plant becomes a habit with the operator.

As we have said, the field for central heating is enormous, both on the large scale, such as the heating of offices, municipal buildings, shops, schools, and the like, and in the "better class" domestic premises. In his Paper Mr. Bishop particularly stresses the importance of cultivating the "better class" householder. We would add emphasis to this, for we have as yet hardly touched the fringe of business of this type. What we regard to-day as large heating loads ought in the not distant future to appear by comparison small loads, such is the extent of the field. The provision of gas central heating to 1% of the gas consumers in this country would increase sales by about 10%. In pushing gas for central heating the difficulty is often encountered of existing plants—usually solid fuel fired. Mr. David Fulton referred to this matter in his recent Paper on domestic central heating to the North British Association of Gas Managers. He feels that the great majority of the people who betray an interest in gas as a fuel for central heating are those who have become weary of the labour needed by the solid fuel boiler and its irregular performance. In most instances, however, they are reluctant to scrap the existing boiler, but ready to lend a willing ear to suggestions of converting the existing boiler to gas firing. While sharing our view that the aim should be the installation of a boiler expressly designed for gas, Mr. Fulton is satisfied as a result of experience that conversions from solid fuels to gaseous firing can be undertaken confidently. In this connection it may be mentioned that, with a price for the load of 5d. a therm, the Derby Gas Undertaking has already about fifty conversion sets in use, efficiencies of well over 75% having been obtained. If we set about the work confidently we are certain to develop the gas central heating load enormously. We want the right tariff and the right type of men to "put it over"—staff fully conversant with the special requirements of this class of work.

"Light on the Roads"

Last week we reviewed in these columns the Final Report of the Ministry of Transport Departmental Committee on Street Lighting—a document obviously of the greatest importance to the Gas Industry and one which will have a far-reaching effect on the illumination of our roads. The ultimate responsibility for putting the new standards of lighting into practice will devolve upon members of public authorities, and it is most desirable that all public men should be familiar with the recommendations of the Report and with the fact that gas can adequately fulfil all the requirements set out in it, while at the same time offering the greatest dependability, economy, and the highest standard of maintenance of uniform results. The Report is a lengthy and a highly technical document, but the British Commercial Gas Association has published a booklet, bearing the title "Light on the Roads," which interprets the main provisions of the Report clearly and simply. It is an exceedingly well written, well illustrated, and well produced publication explaining how the specific recommendations of the Street Lighting Committee can be carried out, and how completely equipped the Gas Industry is to assist in each and every type of lighting scheme. We can imagine no better or fairer interpretation for the layman of the Street Lighting Report. The Committee's main recommendations are summed up under five heads and it is shown how efficiently and economically gas can fulfil the standards of lighting which are considered desirable. Gas undertakings throughout the country would be well advised to make themselves acquainted with this useful and timely B.C.G.A. publication and to see to it that all councillors in their districts of supply have copies placed in their hands. "Light on the Roads" is a first-rate effort. Full advantage should be taken of the opportunity it affords of assisting the cause of gas lighting and giving those responsible for the lighting of our thoroughfares an idea of the service which the Industry is equipped to offer.

"Time and Tide"

Eminent scientists have in the past, we are told, been at pains to prove that "Time and tide wait for no man." No one—with the possible exception of H. G. Wells and King Canute—has made any serious attempt to dispute this theory, which has its counterpart in the Gas Industry's pass-word, "The Junior of to-day is the Senior of to-morrow." The modern King Canute in the Gas Industry is Mr. R. N. LeFevre, who, sitting in his presidential chair upon the shore of faithful service, has arrived at the conclusion that the tide of promotion does not envelop all those who merely stand and wait—and therefore the term "Junior" is effete so far as it is applied to Gas Associations. We do not know how much fundamental research has been required to enable Mr. LeFevre to reach this epoch-making discovery; but there is little doubt that he is right—up to a point. Indeed, we cannot help feeling that it would be extremely awkward if all the Juniors of to-day became automatically Seniors to-morrow. Executive positions in the Industry would be—to say the least of it—just a little overcrowded—though we would not go so far as to say that this would not provide a partial solution of the unemployment problem.

Possibly Mr. LeFevre, in the first tide of youthful enthusiasm, has taken compassion upon the hoary heads which he sees about him at Junior Association meetings; perhaps it causes him acute embarrassment to think of members old enough to be his father as "Juniors." But on this reckoning there are several members of Senior Associations who should still be among the submerged tenth. Or is it that Mr. LeFevre doesn't like the idea of members occupying such elevated positions in the Industry, as some of them do, being stigmatized "Juniors?" But what does the appellation "Junior" mean and is there an opprobrious interpretation of the term? Does it mean junior in knowledge, junior in experience, or merely junior in years? Surely the course is clear. If a member considers himself no longer eligible for membership of a Junior Association by reason of his being unable—*in his own opinion*—to comply with any of the three provisos mentioned above, he can either apply for membership of a senior body, where, doubtless, his wealth of knowledge will gain him a ready entry—or else quietly hand in his portfolio and take up bee-keeping.

In our opinion there is in the Gas Industry nothing invidious in being styled a "Junior." And if we take away our proverb what is left for the Juniors to work for? Perhaps a sort of half-way house is needed—an "Intermediate Association," through which the aspirant may graduate by easy stages to the goal of "Senior-ism." On this basis, however, surely there should be yet a fourth grade—an "Association for Antiquated Gas Engineers and Managers."

Personal

Many of our readers will have followed with interest the reports of last week's debate in the House on Civil Aviation, which was initiated on Nov. 17 by Mr. W. R. D. PERKINS. Before entering politics, Mr. Perkins went through the works and various departments of Messrs. R. & J. Dempster, Ltd., of which firm he is still a Director.

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Mr. THOMAS BAIRD, M.A., A.R.P.S., of Film Centre, Ltd., has been appointed Film Officer to the British Commercial Gas Association.

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The Liverpool Gas Company on Monday appointed Mr. ERNEST ASTBURY to the post of Chief Engineer, in succession to the late Mr. R. E. Gibson. Mr. WILLIAM FLETCHER will succeed Mr. Astbury as Assistant Chief Engineer.

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Mr. J. STRONG has resigned from the position of Secretary to the Wigton Gas Company, and is succeeded in that office by Mr. S. BLAIR.

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In succession to the late Mr. H. B. Rossiter, Mr. R. C. TAYLOR, Engineer and General Manager, has been appointed to fill the vacancy thus caused on the Board of the Torquay and Paignton Gas Company.

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Mr. L. BRUSH, of Silloth, has been appointed Engineer and Manager of the Millom Gas Department, in succession to Mr. T. H. RICH, who recently retired.

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After 40 years' service as Engineer and Manager of the Machynlleth Gas Company, Mr. J. W. LANE is retiring. Mr. Lane comes of a family which has been associated with the Gas Industry for three generations.

Obituary

Sir John Ferguson Bell

On going to press we learn with deep regret of the death of Sir John Ferguson Bell, M.I.C.E., J.P., Chairman of the Derby Gas Light and Coke Company, at Ivy House, Mickleover, Derby.

Sir John, who was 81, was President of The Institution of Gas Engineers in 1925. A funeral service will be held in Derby Cathedral on Thursday, at 1 p.m., prior to cremation.

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We regret to report the death recently of Mr. C. P. KNIGHT, age 69 years, who was Manager of the Belfast Branch of W. Parkinson & Co. since 1903, and who served the firm for 47 years. The late Mr. Knight was not only a practical man and able gas meter technician, but a first-class representative who was held in high esteem by all his business associates in Northern Ireland. At the funeral the Company was represented by Mr. William W. Parkinson, Mr. F. S. Clegg (who has succeeded Mr. Knight), and other employees from the Branch. Mr. J. D. Smith, Engineer and Manager of the Belfast Gas Department, and other officials representing the Gas Industry in Ireland also attended the funeral.

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We regret to record the death on Nov. 20, at the Fairways, Penns Lane, Erdington, Birmingham, of Mr. JOHN HENRY COX, after a long illness. Mr. Cox was a Director of Messrs. Sperryn & Co., Ltd., Moorsom Street, Birmingham, which Company he joined as a junior some 30 years ago. His energies were devoted to the department supplying special apparatus to gas undertakings, among the personnel of which he had a large number of close friends. Mr. Cox was a Freemason, and until his death was Secretary of the Lodge of Integrity, Warwickshire, No. 4,563.

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The funeral of Mr. RALPH E. GIBSON, whose death was recently announced in these columns, took place on Nov. 10. The large attendance of mourners constituted a striking tribute to the affection and esteem in which he was universally held. In addition to family mourners and personal friends, the Liverpool Gas Company was represented by Mr. E. Bateson, Deputy-Chairman, Mr. Kenney Tyrer, Mr. E. B. Royden, and Lieut.-Col. Buckley, Directors, Mr. Sandon Stubbs (Secretary and Treasurer), Mr. E. Astbury (Assistant Engineer), Mr. W. Fletcher (Superintendent, Garston), Mr. H. Nicholl (Superintendent, Athol Street), and Messrs. H. W. Hodgson, W. B. Payne, W. Norris, S. Carter, T. J. Burns. There was also present a great number of Mr. Gibson's professional friends and associates from the Gas Industry.

Correspondence

Non-Aerated Flames in Gas-Ovens and Improvements in Oven Design

SIR,—While endorsing the whole of the article on this subject which appeared in the "JOURNAL" on Nov. 3, p. 345, I desire to concentrate on one point which transcends in importance all others—the easier cleaning of the oven's interior. Housewives by the million would prefer that the next improvement to the gas-cooker should make it easier to clean, and if this could be accomplished there are millions more waiting to exchange their cookers for gas-cookers.

In the early days, designers of necessity had to concentrate on thermal efficiency; hence the insulation of the oven sides. To-day, with the great reduction in gas consumption due to improved burners, this need does not exist, so that designers can make the convenience factor their chief goal.

Seeing that "Prevention is at all times better than cure," I ask the author if, with the sheet metal and unlagged gas-cooker of his experiment, the grease (relative to the present-day normal insulated cooker) was deposited in less degree, and if it was more easily removed?

H. J. TOOGOOD.

43, *Uxbridge Road,*
Hampton-on-Thames.
Nov. 17, 1937.

Forthcoming Engagements

Nov.

25.—I.G.E.—Purifiers Committee, 2.30 p.m. Gas-Works Safety Rules Committee, 3 p.m.

26.—GAS COMPANIES' PROTECTION ASSOCIATION.—40th Annual General Meeting, Caxton Hall, Westminster, 2.30 p.m.; followed by Committee Meeting.

26.—NORTH OF ENGLAND AUXILIARY.—35th Half-Yearly Meeting at Newcastle-upon-Tyne.

27.—SCOTTISH WESTERN JUNIORS.—Visit to Auchengeich Coke Ovens.

29.—W.G.C.—Meeting of Executive Committee, Gas Industry House, 11.30 a.m., followed by Meeting of General Consultative Committee and Business Session at 2.30 p.m. Address by Lady Sanderson, J.P.

30.—W.G.C.—Meeting of Training Committee, Gas Industry House, 10.30 a.m.

(There will be no meeting of the Central Executive Board of the National Gas Council or of the Central Committee of the Federation of Gas Employers during the month of November.)

Dec.

1.—LONDON AND SOUTHERN JUNIORS.—Visit to W. H. Allen's Engineering Works, Bedford.

2.—I.G.E.—Liquor Effluents and Ammonia Committee, 11.15 a.m.; Joint Research Committee, 2.30 p.m.

2.—MIDLAND JUNIORS.—Meeting and Paper by F. A. C. Pykett on "Re-selling the Cooker Load by Vitreous Enamelling."

3.—I.G.E.—Research Executive Committee, 10.30 a.m.; Advisory Committee on Research, 2.30 p.m.

4.—MANCHESTER AND DISTRICT JUNIORS.—Visit to Manchester Oxide Company, Ltd. Papers by R. H. Clayton and H. B. Avery.

9.—SOUTHERN ASSOCIATION (EASTERN DISTRICT).—Meeting at Gas Industry House, 2.30 p.m. Discussion "Re-Organization of Maintenance Service at Brighton."

11.—WESTERN JUNIORS.—Visit to Trowbridge Gas-Works. Paper by V. J. Borrett on "Works Extensions at Trowbridge."

11.—SCOTTISH JUNIORS.—Joint Meeting at Glasgow. Address by G. Dixon (Junior Vice-President of the I.G.E.).

11.—YORKSHIRE JUNIORS.—Visit to Hopkinsons, Ltd., Huddersfield.

13.—I.G.E.—General Purposes Committee, 11 a.m.; Finance Committee, 1.45 p.m.; Membership Committee, 2.15 p.m.; General Purposes Committee, 3 p.m.

14.—I.G.E.—Council, 10 a.m.; Gas Education Executive Committee, 2.30 p.m.

News in Brief

CURRENT EVENTS IN THE GAS INDUSTRY

The Tender of Messrs. Firth Blakeley, Sons, & Co., Ltd., for the erection of a new gasholder has been accepted by the Hunstanton Urban District Council.

For the Issue of Additional Capital the Woking District Gas Company give notice that they intend applying to the Board of Trade under the Gas Undertakings Acts, 1920 to 1934, for a Special Order.

An Application From 300 Residents on the new Cleadon Estate asking for a gas supply on the grounds that electricity is too costly for heating and cooking will be considered at the next meeting of the South Shields Housing Committee.

Volunteers Were Invited by the Croydon Gas Company on Monday, when repairs were needed to a gas fire in the bedroom of a typhoid patient. A young fitter, Albert Walters, offered his services, and carried out the work wearing overalls and a mask.

A Meeting of the Auxiliary Section of the North of England Gas Managers' Association will be held in Newcastle on Nov. 26, when a Paper will be read by Mr. R. Aynsley, of the South Shields Gas Company, on "Prepayment Meter Administration and Collection."

A Paper on "Incandescent Gas Lighting" will be read by Mr. Dean Chandler, of the South Metropolitan Gas Company, at a meeting of the Illuminating Engineering Society to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, on Dec. 14, at 6.30 p.m.

Application Forms for the 1938 Associate-Membership Examination of the Institution of Chemical Engineers, together with the Memorandum on "The Training of a Chemical Engineer," may be obtained from the Hon. Registrar, Institution of Chemical Engineers, 56, Victoria Street, S.W. 1.

At a Public Auction twenty-seven parcels of £1 ordinary shares in the Minehead Gas-Light and Coke Company, totalling 546 shares, realized an average of 39s. 2½d., the top price paid being 40s. For some years a dividend of 8%, less tax, has been paid on these shares. At the same sale £100 of 4½% redeemable debentures were sold for £113 10s.

In last week's "Journal," p. 575, referring to an increase of capital of South Eastern Tar Distillers, Ltd., we stated that the Company is controlled by Messrs. Burt, Boulton, & Haywood, Ltd. Actually, though Messrs. Burt, Boulton, & Haywood are substantial shareholders, they do not control the Company. The other principal shareholders are Messrs. Lane Brothers (Tar Distillers), Ltd., and the South Eastern Gas Corporation, Ltd.

A Proposal to Build a New Gas-Works at Neyland, Pembrokeshire, has been discussed by the Local Council, and a resolution to that effect is on their books. The annual lease, which is claimed on the present site, is considered too onerous. One alternative rejected by the Council was to buy gas from the nearby Milford Haven Gas-Works. A decision is expected within the next few months. The annual sale of gas at Neyland last year was 6 million cu.ft.

In Our Issue for Nov. 3, p. 338, we referred to the working results of an installation of C.O.L. intermittent vertical chambers at the Stalybridge Gas-Works during April-September of this year. In connection with thermal yield it was stated that "if benzole had not been stripped from the gas, this would have resulted in the production of mixed coal gas and water gas amounting to 94·5 therms of 500 B.Th.U. gas per ton." The figure of 94·5 therms should read 92·38 therms.

An Exhibition and cookery demonstrations were held in the Geilston Hall, Cardross, from Nov. 15 to 20 by the Dumbarton Gas Department. Presiding at the opening ceremony, which was performed by Miss Eunice Murray, J.P., Provost Campbell said that Cardross had been without gas till three weeks ago when it commenced to receive a supply from Dumbarton. The latter had doubled its gas output in the last 20 years. Firms co-operating in the exhibition were Messrs. R. & A. Main, Ltd., Milne & Mitchell, Electrolux, Ltd., and Messrs. John Wright & Co.

Mr. N. G. Appleyard, Manager of the Meadow Lane Works of the Leeds Corporation Gas Department, addressed the Leeds Civic Forum, on Nov. 18, on Gas and its history and services. Mr. C. S. Shapley, Engineer and General Manager, supported the remarks of Mr. Appleyard, observing that although the Department was now having to pay substantially more for coal than hitherto the price of gas had not been increased.

The First of a Series of winter lectures arranged for the employees of the Sales and Distribution Departments of the Sheffield Gas Company took place at the chief showrooms, 15-17, High Street, Sheffield, on Nov. 19. The lecturer was Mr. L. Marshall, of Messrs. James Stott & Co. (Engineers), Ltd., Oldham and Leeds, and the talk was mainly confined to the construction and maintenance of gas catering equipment. The various models exhibited and the drawings shown contributed greatly to a most successful evening. At the conclusion of the talk there was an interesting discussion.

Favourable Progress by the Appleby Gas Department was reported by the retiring Mayor, Councillor J. F. Whitehead, in a review of his year of office at the Council's "Mayor's Day" meeting. The use of gas in the Borough, he said, was increasing year by year. A new showroom had been opened, and a most satisfactory feature was the improvement in the sales of cookers. The ratepayers were more and more appreciating the value of gas as a means of heating and lighting. Referring to the new gasholder, which is in course of erection, the Mayor paid tribute to the contractors, Messrs. Balfour & Co., who, though faced with rising costs, were fulfilling their contract at the original price.

Members of the Midland Section of the Junior Institution of Engineers (Incorporated) visited the Wellington Tube Works, Ltd., at Great Bridge, Staffs, on Wednesday, Nov. 17, and the party, under the direction of Dr. C. M. Walter, of the Birmingham Gas Department, were received by Mr. D. W. Turner, Chairman and Managing Director of the Company, and were greatly interested in the various processes of manufacture witnessed in the tour of inspection. With the vote of thanks expressed by Dr. Walter at the conclusion of the visit, members of the party acclaimed the tour as one of the most enjoyable of their experiences, and Mr. Turner, in acknowledgment, hoped that the occasion had afforded as much pleasure to the members as it had to members of the Company and himself.

Owing to a Strike of employees of the Alliance and Dublin Consumers' Gas Company, the Lord Mayor did not attend the distribution of prizes in connection with a baking competition which recently took place at the Theatre of the Company. Mr. W. J. Grey, General Manager, in a speech before distributing the prizes, apologized for the absence of the Lord Mayor, who, he said, had not thought it prudent to attend, owing to the presence of pickets outside the showrooms. From their point of view, added Mr. Grey, it was only right to say that the few men who were on strike went out without making a request to the Company for an improvement in their conditions. The competition was highly successful, however, the entries totalling over seven hundred. The theatre was crowded for the proceedings, and an adjoining hall, to which the speech of Mr. Grey was relayed, was also packed.

An Exhibition arranged by the Watford and St. Albans Gas Company was recently held in the Hatfield (Herts.) Masonic Hall. The exhibition was opened by Mr. Walter Clarke, J.P., Chairman of the Hatfield Rural District Council, who was introduced by Mr. C. S. Knowles, District Manager. Mr. Clarke observed that it was about 80 years ago when the first Gas Company was formed in Hatfield. Regarding public lighting, Councillor Clarke said the Council had inspected installations in all parts of Hertfordshire and part of Middlesex to discover the best lighting medium. They had decided on a type of gas lighting which, he thought everyone would agree with him, was very satisfactory. He wished the exhibition every success. Mr. G. Wilkes, General Manager of the Watford and St. Albans Gas Company, thanked Mr. Clarke. Features of the exhibition were cookery demonstrations, film shows, and television demonstrations. Co-operating firms were Radiation Ltd., Ascot Gas Water Heaters, Ltd., and Messrs. W. H. Dean & Son, Ltd.

Amalgamation and Grouping

Stellite, Ltd., and Llandudno.

Information was given at a Llandudno Council Meeting last week concerning the Urban Council's proposal to sell the town's municipal gas undertaking to Stellite, Ltd., of Queensferry. Reference to the proposed sale was made in our issue of May 5, p. 262.

It is suggested that the Council should accept Stellite's offer of £107,000 or the amount of the outstanding loan debt on the gas undertaking, which may be a little more, subject to the following conditions: (*a*) The offer includes the whole of the assets of whatever descriptions standing in the Council's books on March 31, 1937, the Council to discharge all the liabilities of every description. (*b*) The price of gas to ordinary consumers shall be reduced by 4½d. per 1,000 cu.ft., and a sliding scale to be inaugurated depending upon the consumption down to a minimum of 2s. per 1,000 cu.ft. (*c*) The Council to enter into an undertaking for a period of ten years to continue to take a supply of gas amounting to approximately 14 million cu.ft. at a price of 2s. 4½d. per 1,000 cu.ft. (*d*) The maximum price shall be 1s. 3d. per therm, and the maximum dividend payable by the Company 6%. After the expiration of three years the Board of Trade shall fix a basic price, which basic price shall be subject to that for every ½d. reduction in the price of gas per therm, 3s.% shall be payable beyond the 6%, or *vice-versa*. (*e*) That the Company will be known as the Llandudno Gas Company, Ltd. (*f*) The Company shall continue the services of all employees under no less favourable conditions than existing on March 31, 1937.

British Gas Federation

Annual General Meeting

The third Annual General Meeting of the British Gas Federation was held at Gas Industry House, 1, Grosvenor Place, S.W. 1, on Wednesday, Nov. 3, 1937. Sir DAVID MILNE-WATSON, Bart., LL.D., D.L., Chairman of the Council, presided.

Minutes of the Second Annual General Meeting held on Nov. 4, 1936, having been circulated, were taken as read, confirmed, and signed.

Third Annual Report.—The Third Annual Report for the year 1936-37 was approved and adopted, and it was decided to supply the Constituent Bodies with copies for their members.

Election of the President.—Lord Dudley, who had acted as President for the Federation for the past two years, was unanimously re-elected President of the Federation for the year 1938.

List of Council Representatives for 1938.—The following list of representatives of the Council for the year beginning Jan. 1, 1938, was reported:

Representing National Gas Council.

Sir David Milne-Watson, Bart., LL.D., D.L.
Wm. Cash, F.C.A., J.P.
T. P. Ridley, F.C.I.S.
C. S. Shapley, M.I.Mech.E.
A. W. Smith, F.C.I.S.

Representing British Commercial Gas Association.

S. E. Halliwell, F.C.I.S.
J. Jamieson.
A. M. Paddon, M.Inst.C.E.
J. Sandon Stubbs, F.C.I.S., Chairman of the Executive Committee.

Representing Institution of Gas Engineers.

Colonel W. M. Carr, O.B.E., T.D.
G. Dixon, B.Eng., M.Inst.C.E.
Stephen Lacey, B.Sc., M.Inst.C.E.
Robert Robertson, M.Inst.C.E.
H. C. Smith, M.Inst.C.E.

Representing Gas Companies' Protection Association.

C. F. Botley, M.Inst.C.E.
H. E. Bloor, B.Sc., B.Eng.
F. G. Brewer.
R. W. Edwards, J.P.
R. Halkett.

Representing Society of British Gas Industries.

D. M. Henshaw.
Colonel O. B. F. Planck, D.S.O., T.D., D.L.
F. B. Richards, M.B.E., M.Inst.C.E., M.I.Mech.E.
R. J. Rogers.
H. M. Thornton, J.P., A.Inst.C.E., M.I.Mech.E.

Auditor.—A hearty vote of thanks was accorded to Mr. Morland, F.C.A., for auditing the accounts, and he was unanimously re-elected Auditor for the forthcoming year.

Special Business.

The following special business was considered—namely, the supply of steel work for the Gas Industry. It was reported that serious delay had taken place in the delivery of steel work in all parts of the country, rendering it difficult and sometimes impossible for contractors to erect plant which should have been in operation this winter. The Joint Secretaries had obtained definite information on this point from many undertakings throughout the country, and while in some cases the position appeared to be improving, in others great difficulty was still being encountered. The following resolution was passed unanimously and the Joint Secretaries were instructed to forward this with an appropriate letter to the British Iron and Steel Federation: "That the British Iron and Steel Federation be requested to take all possible steps to ensure adequate and prompt supplies of steel where the work is of national importance in connection with the Gas Industry, which is one of the principal Public Utilities in the country."

Why Sunday Dinner Was Late

Electricity Failure in East Surrey

Midday dinner in many all-electric homes in East Surrey was delayed last Sunday by an electricity failure. Towns affected were Esher, Thames Ditton, Walton-on-Thames, and Weybridge.

The supply failed as a result of a local breakdown a few minutes after 10 o'clock. About two hours later the supply was restored, but failed again. At 3 p.m. the fault was finally repaired. Hospitals in Walton and Weybridge were affected, but neither was inconvenienced.

There was also a half hour's failure of electricity at Lewes, Sussex, on Saturday night. An orchestra at the first Founders' Day concert of the Sussex Rural Community Council played "Oh, dear, what can the matter be?" During the black-out the fire brigade received two calls—one to a chemist's shop and the other to a house.

L.C.C.A. Distributors' Branch

First Annual General Meeting

The first Annual General Meeting of the London and Counties Coke Association Distributors' Branch was held on Nov. 12 at Gas Industry House, under the Chairmanship of Mr. John Charrington, Jnr. (Chairman of the Central Committee of the Distributors' Branch).

The meeting was open to the London and County representatives, and over ninety members were in attendance. (There is a county representative for each area covered by each Gas Company member of the London and Counties Coke Association.)

Mr. Charrington in his opening remarks said that there was evidence over the thirteen south-eastern counties covered by this Branch that its roots were firmly established, and that as the trust and confidence between producers and distributors improved the better would be the terms under which members of the Branch would be able to distribute coke. He suggested that coke would play a part of ever-growing importance in distributors' business.

The first Annual Report was taken as read, and the meeting concluded with a speech from Mr. R. W. Foot (Chairman of the London and Counties Coke Association), who said that he appreciated the fact that he had been invited to attend the meeting and to hear the questions and criticisms that were raised in connection with the working of the coke scheme, and also to know that the atmosphere between distributors and producers was sufficiently good to make this possible. In reviewing the position as it affected distributors in the years since 1931, when the London and Counties Coke Association was formed, he was pleased to see that, generally speaking, distributors had become more and more interested in coke, and in a number of cases had been glad to avail themselves of the services of the Association to convert business from the use of bituminous coal to smokeless fuel. In fact, many distributors had taken the view that the more coke they could get on their books the better it would be for them in the future. Mr. Foot spoke of the continued increase in the demand for coke, and referred to the new uses which had been developed and the fact that the reputation of coke with heating engineers, architects, and householders was higher to-day than ever before. He urged distributors to continue to take the long view and to keep coke very much on their books so that they would be ready to branch out with the new opportunities as soon as supplies became plentiful again—as they surely would. He dealt at length

with the immediate question of supplies of coke, and said that it would be a mistake to think that because supplies might be difficult to-day they would be difficult in years to come, for there was more coke being produced in this country at the present time than ever before, while the supply of furnace coke to iron and steel industries had more than doubled since 1932.

Mr. Foot's Address ended with congratulations to the Chairman and members of the Branch for the way they had got together in such a short time. He commented on the complete business organization of the Distributors' Branch which is established with over 3,500 members and properly appointed County Committees and a Central Committee.

Junior Gas Associations Joint Council

Annual Meeting

The Annual Meeting of the Joint Council was held at Watson House, London, on Oct. 25, 1937—Mr. R. N. LEFEVRE (London) presiding.

The following delegates from the various Associations were present:

London and Southern District Junior Gas Association.

S. C. Waldock (Gas Light & Coke) F. H. Higton (East Surrey)
H. J. Risby (South Metropolitan)

Manchester and District Junior Gas Association.

J. Albinson (Manchester) F. Johnston (Manchester)
H. Platt (Bolton)

Midland Junior Gas Association.

E. T. Pickering (Birmingham) A. Hill (Birmingham)
A. T. Attwood (Coventry)

Wales and Monmouthshire Junior Gas Association.

H. V. Williams (Cardiff) K. M. Ernest (Cardiff)
R. S. Snelling (Newport, Mon.)

Western Junior Gas Association.

J. E. Akroyd (Swindon) K. L. Clark (Weston-super-Mare)
A. Tran (Bath)

Yorkshire Junior Gas Association.

E. R. B. French (Leeds) R. H. McCulloch (Sheffield)
J. Richmond (York)

Scottish Junior Gas Association.

R. A. MacLaren (Newton-on-Ayr) W. Kirk (Motherwell)

Educational Representative.

W. J. Pickering (Birmingham)

Hon. Secretary and Treasurer.

A. Bujnowski (Glasgow)

The minutes of the Meeting held at Glasgow on Sept. 25, 1936, having been circulated, were taken as read and on the motion of Mr. Snelling were approved and signed.

Mr. Bujnowski submitted his report for the year, and on the motion of Mr. TRAN, seconded by Mr. AKROYD, this was approved, and the Secretary was accorded a very warm vote of thanks for his work during the year.

Mr. Pickering submitted his Educational Representative's Report, in the course of which he referred to the additional amendments made during the last few months to the 1934 Revision of the Regulations. In expressing again their best thanks to all concerned with the administration of the Scheme, Mr. Pickering mentioned particularly the special work carried out by certain members of the Executive Committee in connection with the Revision of the Regulations.

This work had to be got through quickly at a time when the holiday spirit was abroad, and in this connection he paid special tribute to Mr. John Terrace, the Vice-Chairman of the Gas Education Committee, who spared no trouble to see the job through, so that the "Blue Book" might be available for the commencement of the new session.

On the motion of Mr. FRENCH, seconded by Mr. E. T. PICKERING, the report was adopted, and Mr. Pickering was very warmly thanked for his work. It was agreed that this report be issued to the delegates in future in time for consideration prior to the meeting.

Mr. Hill submitted his report in connection with the Joint Junior visit to the British Industries Fair on Thursday, Feb. 18, 1937, when 270 members were again the guests at luncheon of the Birmingham Chamber of Commerce. A report of the proceedings will be found in the "GAS JOURNAL" for Feb. 24, 1937.

On the motion of Mr. HIGTON, Mr. Hill was thanked for the very satisfactory report and the splendid work done in connection with the visit.

Mr. HILL stated that the intention was that the invitation be repeated, but to date no official intimation had been received.

Mr. AKROYD moved, and Mr. SNELLING seconded, that the Junior Associations be recommended only to accept, for the purpose of visits, reasonable hospitality from the manufacturers of appliances or materials used in the Gas Industry.

The SECRETARY intimated that the Yorkshire Association were due to act as hosts to the Joint Council, and Mr. RICHMOND on behalf of the Association extended a warm welcome to the delegates to Yorkshire, the place to be intimated later.

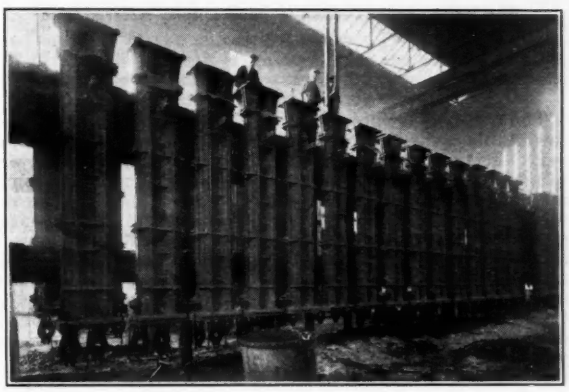
The CHAIRMAN raised the matter of the title "Junior" Gas Associations and suggested that the word "Junior" might well be eliminated in view of the many senior members of the Industry who held offices in the Junior Associations. Mr. FRENCH supported the Chairman in this matter, and Mr. TRAN moved that The Institution of Gas Engineers be asked to submit an alternative title. The matter was fully discussed, and the Secretary was finally instructed to take the matter up with the Secretary of The Institution of Gas Engineers and report at the next meeting.

This concluded the business, and the Chairman was accorded a cordial vote of thanks.

Following the meeting the delegates were entertained at lunch by the Gas Light and Coke Company at Watson House, when Mr. Holliday (Assistant Technical Officer) expressed the pleasure of the Company in having the Juniors at Watson House. Mr. Snelling returned thanks on behalf of the Council.

In the afternoon a tour of Watson House was arranged, during which a series of gas films were shown. At the conclusion of the tour, members were entertained at tea.

Gas for Mould Drying



Above is a photograph of cast-iron pipe moulds at the foundry of Messrs. J. & R. Ritchie, Ltd., Middlesbrough, in which gas is used for the mould drying. The mould boxes are erected vertically in the casting shop in two rows with a charging platform between. There are 20 boxes making 9 ft. lengths of 3-in. pipe, 52 boxes making 12 ft. lengths of 4 in., 20 boxes for 12 ft. lengths of 6-in., and 8 boxes for 12 ft. lengths of 8 in. pipe. The pattern is placed in the box, the sand rammed tight, and the mould dried by means of an open flame gas burner at the bottom of the box. The drying takes 1¾ hours for a cold box to under the hour for a heated box. The output is 12 to 15 tons per day, and the annual gas consumption is 4 to 5 million cu.ft.

A Hundred Years of Gas at Dunmow

New Showrooms Opened

For an enterprise of its size, the Undertaking of the Dunmow Light and Heat Company, now celebrating its centenary, must surely have been among the earliest in the field. On the completion of one hundred years' service, the concern is going ahead in a most satisfactory manner. The Directors in their report for the year ended June 30, 1937, state that records have been established in three directions. First, there has been a substantial increase in gas sales and profits; secondly, for the first time in the history of the Company a showroom has been opened; and, thirdly, the Company have been successful in concluding a five-year contract for public lighting, under which they intend to improve the standard of illumination and to erect many more lamps.

The Dunmow Light and Heat Company took over the

former Dunmow Gas Company in 1934, and Mr. G. Beeton was appointed Engineer, Manager, and Secretary. In their annual report the Directors congratulate Mr. Beeton, who was formerly at Cheddar, and the staff upon the gratifying result of a year's working. In the year that the Undertaking was acquired by the Light and Heat Company, a three-years' public lighting contract was obtained in keen competition with the local Electricity Company.

The population of Dunmow is 2,882, and the number of consumers served by the Company is 606. The annual sales of gas by the Company, whose capital is £9,000, total over 11 million cu.ft.

THE GRATIFYING RESULTS OF HOME SERVICE

Bristol Maintains Contact with Its 120,000 Consumers

With a view to stimulating public interest in the more general use of gas for domestic purposes and the services available to consumers provided by the Home Service Section of the Bristol Gas Company, a special month's campaign has been successfully carried out at the opening of the winter session with gratifying results.

The Home Service Section Window Display referred to in our Article.

The Grocers' Exhibition at the Bristol Coliseum provided a suitable opportunity for valuable propaganda, and a very effective and practical exhibit was designed and arranged by the Sales Staff. The display of modern appliances with attractive surroundings, an illuminated working exhibit of water heating appliances, and cinematograph effects with a cooker exhibit to "catch the eye" of the visitors, had a definite appeal. The resulting business and enquiries were entirely satisfactory, and as 70,000 people visited the Exhibition, the modern outlook of the Industry, with its offers of practical service to the housewife was impressed upon a very wide circle of the Bristol public.

Press advertisement, extensive circularization, and personal visits by the Home Service Staff to centres of influence in educational and women's organizations were very effective in creating special interest in the Company's varied activities, and 20,000 people visited the Company's modern showrooms during the month, where the enterprise of the Gas Industry and the desire to serve the consumer in every possible way, was further emphasized and undoubtedly appreciated.

In such an encouraging atmosphere the Home Service Section co-operated whole-heartedly with commendable zeal and efficient organization. Special demonstrations and competitions were arranged and visits of numerous parties from women's associations organized. Over 5,000 people attended the public and private demonstrations in what is happily called the "Little Theatre," the Company's Conference Room, in various surrounding districts, and at the Grand Hotel, where a series of lectures, arranged in conjunction with the Bristol *Evening World*, were given by Mrs. Hardy, of Radiation Ltd. The Company's Chief Demonstrator, Miss Grace Richardson, with her staff of specially trained assistants, arranged the whole of the lectures, with marked success, and the administrative details were efficiently organized by Mrs. Marion Clark, Organizing Secretary, and the Staff of the Home Service Section.

Evening Classes for Business Girls.

Special evening classes for business girls are arranged on three evenings each week and are very popular. Business firms are impressed with the educative value of these classes and appreciate the enterprise of the Company in providing such facilities for the benefit of their staff.

The National Health Campaign aroused special public interest, and the Bristol Company, with a desire to co-operate in this campaign, linked up their month's activities by arranging special film exhibits and window displays.

The showroom window was utilized by the Home Service Section in a very effective manner and the message drawing attention to the great assistance the Section can render to the public created considerable interest among the consumers. This window display, arranged in conjunction with the film week, illustrated each branch of the Home Service Section in a practical form. The display was an outstanding success, attracting a continual stream of people throughout the week.

The B.C.G.A. films and other films of a topical nature were utilized for the special film display, and these were exhibited in the "Little Theatre" and the Company's Conference Room during the week ended Nov. 6.

Mr. George H. Boucher, Chairman of the Company, performed the opening ceremony, and he emphasized the importance of a careful study of food values and efficient cooking. The Bristol Gas Company showed their special titled film, drawing attention to the activities of the Home Service Section.

Sixteen performances were held and the audiences were drawn from a wide field. Representatives of various social, religious, and political organizations attended the performances, as well as citizens and their wives from all parts of Bristol.

Mr. M. O. McAuliffe (Chief Education Officer, Bristol) gave his permission for school children to attend, and large parties of boys and girls, accompanied by members of teaching staffs, came from most of the Secondary and Elementary Schools. Included in the audiences were members of the nursing profession, domestic science students, and pupils from instructional centres.

Results of Home Service Work.

Since the inauguration of the Home Service Section in the summer of 1935, the number of women visiting the showrooms in parties of 15 to 25 is over 8,000; each party has been specially conducted round the showrooms by the staff and afterwards entertained in the Conference Room. This represents 400 separate parties from 170 women's organizations, who are now directly associated with the Section.

Nearly 6,000 women have been registered as members, and they receive regular invitations to the Company's special lectures and meetings. Over 5,000 women have attended the private demonstrations in the showrooms, while 17,000 have attended district demonstrations, many of which are held at the meeting rooms of the women's organizations.

The weekly lectures at the "Little Theatre" have an average attendance of 400 to 500, and the total attendances since July, 1935, now exceed 20,000, making a total of 42,000 at the various practical demonstrations.

Systematic visitation to consumers' homes for private advice and practical talks are arranged by the demonstrators at the rate of 800 to 1,000 per month, and this service is of incalculable value to the Company in maintaining personal contact with its 120,000 consumers.

A Further Contribution Towards

Solving the Housing Problem

Croydon Company's Latest Enterprise

This photograph shows the front view of the block of flats. The end of the row of houses can be seen on the left.

The problem of adequately housing what are sometimes rather loosely referred to as "the masses" is one which has been exercising the minds of local authorities as well as the Government in recent times. Indeed, valuable contributions in this direction are already in evidence in many directions. In the Metropolis the re-housing of the slum-dwellers is occupying attention—and also in many of the larger industrial centres—while many local authorities are valiantly tackling the problem in the suburbs and the provinces.

It is gratifying to note, however, that the solution is not being left entirely in the hands of the local authorities, and we have already witnessed at least one outstanding example of the part the Gas Industry is able to play in this business of re-housing those who—if not actually coming from slums—at any rate have not enjoyed all the amenities which the modern dwelling, however small it may be, should essentially provide in these enlightened times.

We therefore welcome the opportunity of announcing a further contribution in this direction by another leading gas undertaking. Twenty-two up-to-date dwellings—both houses and flats—have been erected by the Croydon Gas Company, and we had the privilege the other day of inspecting this latest enterprise by an undertaking which has always been in the forefront of progress within the Industry.

It is usually a little difficult to get these undertakings to tell us just why they launch out in a direction which—no matter how laudable—has nothing whatever to do with supplying gas and which in all probability was never contemplated so far as statutory obligations were concerned. Clearly they do not set themselves up as housing authorities with a view to finding an outlet for surplus capital; there are many more remunerative methods. Nor is it necessarily a means of increasing the sales of gas—for the tenants of the new houses probably used gas before, being members of the Company's staff in the case of Croydon.

The truth of the matter is—so far as we are able to understand—that this latest step by the Croydon Gas Company is evidence (though in their modesty they do not admit it) of an enlightened policy towards a national problem and a genuine desire to provide accommodation for their employees of which the latter may well be proud. And, incidentally, such dwellings provide just another opportunity of showing the suitability of gas and coke for the household services. Each, in fact, is a little showroom for gas—and that is the kind of thing the Industry needs more of to-day.

Rigby Close.

The site of the new buildings at Croydon has been called Rigby Close, in memory of the late Mr. Thomas Rigby, Deputy-Chairman of the Company, and consists of a piece of ground previously occupied by a large house in Waddon Road, whose extensive garden backed on to the gas-works. So much for convenient access to the scene of their work on the part of the employees who live on this new estate. It may be mentioned, in passing, that the surface of Rigby Close is covered with a tar carpet, this having been applied since the accompanying photographs were taken.

Facing on to Waddon Road two semi-detached houses were erected, while a block of eight similar dwellings occupy one side of Rigby Close.

The houses are of pleasing design and well constructed, every detail having been considered, even down to the strongly-built fences, with concrete posts, turfed front gardens, and chain posts along the footpath. A large living-room is heated by an "Eagle" coke grate with gas ignition. In the kitchen is a "New World" cooker, a small gas storage heater over the sink, together with a wash-copper neatly slipped away beneath the draining board. This copper works on the "push-out" system, which enables it to supply the hot water for the bath—the bathroom being situated immediately on the other side of the wall. The bathroom itself is semi-tiled and painted in primrose. Upstairs the principal bedroom has a pleasing panel gas fire; the second bedroom is similarly equipped. There is also a third bedroom, together with adequate cupboard accommodation—so important a consideration in the modern small house. Behind each house is a little garden, with access at the bottom to a foot-way running the whole length of the block of houses.

The Flats.

At the farther end, facing up Rigby Close, a block of twelve flats has been built, consisting of three floors and served by two separate stairways.

The equipment of the flats is identical to that of the houses, and here again the rooms are large and well-lighted.

This view of the eight houses in Rigby Close gives a good idea of their pleasing aspect. Though fundamentally similar, the variation of exterior design prevents the tendency towards a stereotyped frontage. In the background, on the right, is a glimpse of the block of flats, a general view of which is given above.

It is also pleasing to find that three bedrooms have been provided—a point which cannot but have a good effect upon the health of the tenants. The principal bedrooms have useful built-in cupboards, and there is a general feeling of roominess—an asset which flats costing many times the rent of these cannot claim.

At the top of each stairway is an emergency exit on to the roof, so that in the event of fire the tenants of one section could escape via the roof down the other staircase. The entrance doors are of the slow self-closing type—which have been adopted deliberately so that the careless banging of the doors shall not disturb shift-workers who may be sleeping during the daytime.

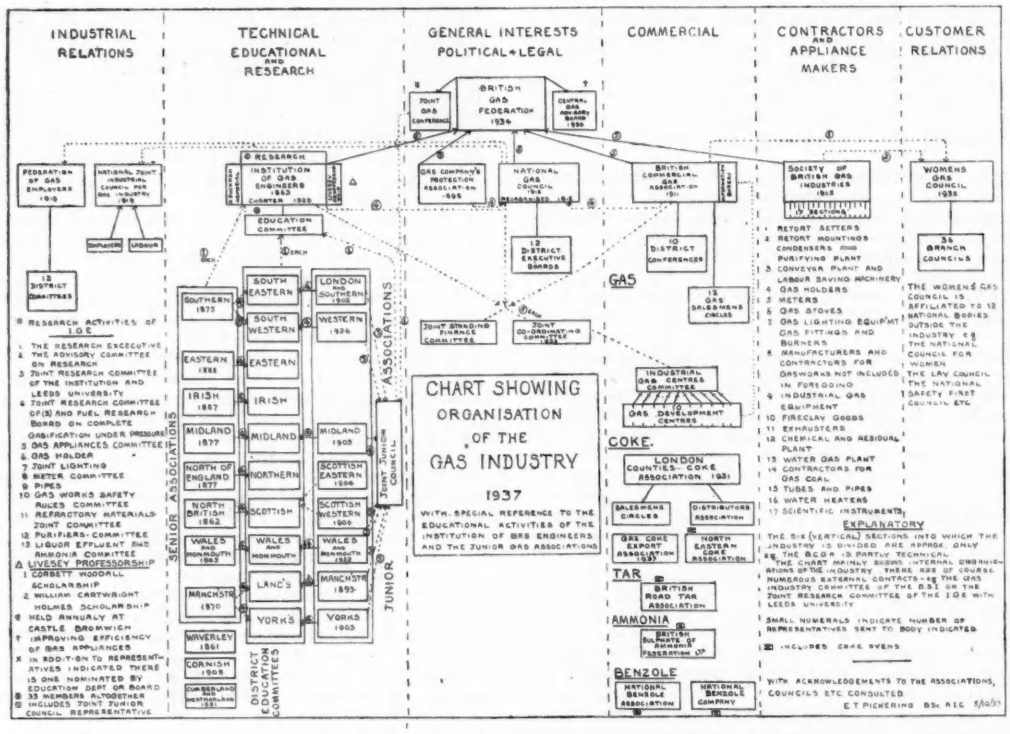
Behind the block is a yard where washing may be hung out to dry, while each flat is also provided with a large shed adjacent to this yard for prams, bicycles, &c. There is also a communal dustbin at the back, into which the tenants empty their individual refuse buckets. On one side of the block is a large piece of ground which the Company intend to turf over as a playground for children.

Both houses and flats are occupied exclusively by members of the Company's staff—principally key-men who may be called out at any time for emergency reasons. To this end one of the houses is fitted with a telephone, thus providing a ready means of getting in touch with any man on the estate. There is a special way out behind the flats for men proceeding to the gas-works.

The rent for both houses and flats is 17s. 6d. per week, which includes rates and water. The tenants have, of course, to pay for their own gas, coke, and electricity. This figure goes to show, however, that the Company are not aiming to make very much profit out of their enterprise, and bears out the theory that they have carried out this scheme with a view not only to offering a substantial contribution towards solving the housing problem, but also to providing their workpeople with homes of which they may well be proud. Perhaps we may call it another interpretation of the " co-partnership spirit."

In conclusion, it should be mentioned that the architect of the new buildings was Mr. J. C. Wilford, F.S.I., of Messrs. Harold Williams & Partners, of Croydon, and the builders were Messrs. Grace & Marsh, Ltd.—also a local firm. The roadwork was carried out by Messrs. Henry Hemmings, Ltd.

Organization of the Industry



This chart showing the internal organization of the Industry was included in the Presidential Address of Mr. E. T. Pickering, B.Sc., A.I.C., to the Midland Junior Gas Association, an abstract of which will be found in our issue of Oct. 27, page 288.

Midland Junior Gas Association

Visit to Fuel Research Station

Thirty-one members of the Midland Junior Gas Association paid a visit, on Thursday, Nov. 4, to the Fuel Research Station of the Department of Scientific and Industrial Research, East Greenwich. The party assembled at 2.30 p.m. and was met by Engineer-Captain J. Fraser Shaw, R.N. (Ret.), the Chief Engineer, who outlined the programme of work being carried out.

The visitors were then conducted in small parties round the Station by members of the Staff. Tea was served at the conclusion of the tour. In proposing a vote of thanks to the Chief Engineer and his Staff, Mr. T. F. E. Rhead, M.Sc., F.I.C., Chief Chemist, Birmingham Gas Department, said it was always a real pleasure to come into contact with the Fuel Research Staff, and be shown round their most interesting and impressive Station. He congratulated Mr. E. T. Pickering upon his far-seeing wisdom in bringing the Association to such an Aladdin's Cave of valuable researches. It was well for the younger men in the Gas Industry to become research-minded, and he felt that the present visit would greatly help in ensuring this desirable result. Among the many things they had seen, the modern high-pressure and synthesis technique held out great promise for the Industry, and he would recommend the members to go further into such matters. To this end they would find it helpful to read the last two annual reports of the Fuel Research Board. He asked Captain Shaw, Dr. King, and Staff to accept the very best thanks of the Association for the kind and helpful way in which they had thrown open the Station for inspection.

Engineer-Captain Fraser Shaw, in reply, said that it was the duty of the Research Station to give information to those who required it, but when they had visitors such as the party there that day, who were keen technical men and could understand the things they saw, then the duty became a pleasure.

AUTUMN RESEARCH MEETING

Nov. 2 & 3, 1937

OF THE INSTITUTION

WRITTEN COMMUNICATIONS AND REPLIES TO THE DISCUSSIONS

14th Report of the Gas Education Committee.—Communication No. 164.

Mr. R. N. Le Fevre (Gas Light and Coke Company) wrote: I should like to add in writing a little more to what I said about day training. It is a difficult enough problem for the large Undertaking, but is very much more so, I imagine, for the smaller one.

Our new scheme for boys has been approved by the Education Committee of the Institution. During their first three years of service these lads do not attend evening classes of any kind. For these years they attend the Technical Institute for one whole day each week, and during the third year they receive full time training in our Training Centre at Watson House.

Any form of day vocational training by outside educational authorities has proved to be impracticable, but preliminary training by them in the day time is highly desirable.

When we come to the major courses many difficulties arise in considering day training. One is the impossibility of obtaining the services of teachers of gas subjects, while another is the fact that the majority of the students are themselves in responsible positions by this time and could not be spared from their normal duties. After all, evening study for such students is not a very serious hardship. It is the young lad of from 14 to 16 years whom we should help if we can and, in this connexion, our new scheme in London may be of interest to members.

40th Report of the Joint Research Committee of the Institution and Leeds University. Combustion Characteristics of Town Gas. - Communication No. 166.

Practical Aspects of the Question.

Mr. L. T. Minchin (Gas Light and Coke Company) wrote: Mr. Wood's Report provides an admirable guide to the general subject of gas combustion characteristics and the use of test burners and flame velocity measurements as an index to these rather elusive properties. At Watson House, concurrently with the general consideration of these problems, our attention has also been directed to the more immediately practical aspects of the question, and it was thought that a brief statement from this point of view might be a useful supplement to the report now under consideration.

In the following notes, therefore, the question of what is the immediate effect of variations in gas quality on present-day gas appliances has been discussed, and it is hoped that this will be of some assistance to both Gas Undertakings and manufacturers of appliances. To the latter this matter is of particular importance since appliances often have to be designed to work on a kind of gas which is not available for testing purposes. Finally, the difficult problem which faces the Gas Undertaking—of correlating A.T.B. Numbers and gas composition—is considered, and some preliminary results of a proposed graphical method of representation are presented.

Effects of Variations on Appliances.

A change in gas composition may affect the performance of a gas appliance using aerated burners in two ways; it may alter the B.Th.U. input by changes in calorific value and specific gravity, or it may alter the character of the flame, in particular the height of the inner cone. The former of these effects is readily susceptible to mathematical treatment and the application of rules of well-tried validity; and, in practice, it is probably more particularly important on appliances which do not employ the Bunsen burner. The second, however, is less easily disposed of, and it is this change in cone height which is most likely to affect performance adversely on any given area of supply. The Aeration Test Burner Number (referred to as the A.T.B. Number) may be regarded as a reliable indication of gas characteristics in so far as they affect the size of the inner Bunsen burner.

A marked change in the A.T.B. Number, whether or not accompanied by other changes, will probably cause gas appliances to function less satisfactorily; and Table A summarizes the principal defects likely to be noticed first, arising from changes in gas quality:

These are the first symptoms; others develop if the situation gets worse, *e.g.*, sooting up.

The degree of change in A.T.B. Number required to produce these effects is difficult to state; because

(*a*) it varies from one design of appliance to the next, and to a less extent from one sample to the next.

Table A.—*Change in Appliance Performance with Change in A.T.B. Numbers.*

Class of Appliance.	Effects of Marked Decrease in A.T.B. Number.	Effects of Marked Increase in A.T.B. Number.
1	2	3
Gas fires and bowl fires ..	Flash back when ignited cold. In some fires a singing noise occurs.	Tendency to incomplete combustion and poor appearance.
Gas irons	Flash back when moving.	Bad combustion when moving.
Cookers	Flash back or flame extinction when hotplate burner turned down to simmering point, and in slight draught.	Tendency to incomplete combustion.
Lighting units	Flickering, followed by flash back to disc or gauze.	Fall in light output.

(*b*) "Difference in A.T.B. Number" is only of significance when the points between which the difference is taken are known. The relation between "difference of ten divisions (50-60)" and "difference of ten divisions (70-80)" is not merely one of inequality; it is indeterminable unless complete data about both gases are given.

Nevertheless, in spite of this difficulty, it may be of interest to state the approximate limits of satisfactory working of the appliances referred to in Table A. For appliances correctly adjusted on 500 C.V. gas between 65-85 A.T.B. they are as follows:

Table B.—*Limits of Change in A.T.B. Number for Satisfactory Performance.*

	Fall of A.T.B. Number to Produce Effects given in Table A.	Rise of A.T.B. Number to Produce Effects given in Table A.
1	2	3
Gas Fires—		
(*a*) Modern fires with single-hole burner-ports and high aeration	10–15	Depends on radiants; can be as low as 13, but often much higher.
(*b*) Modern fires with multi-hole burner-ports and high aeration	30 (for flash back); sometimes very noisy before this point is reached—say at 15	—
(*c*) Older fires with single-hole ports and lower aeration ..	30	—
(*d*) Bowl fires	10	10
Lamps—		
(*a*) Domestic lighting burner with channel-grid nozzle ..	20	
(*b*) Standard pattern street lamp	10	—
Gas Iron (old type)	16	7
Drilled Ring Burners—		
(*a*) On a cooker	20	15
(*b*) On a wash copper ..	30	—

These must be taken as typical results of experiment, rather than generalizations—so much depends upon the particular datum adjustment and upon the personal judgment of the experimenter as to whether or not an appliance has passed the desirable limit, that another worker would be very unlikely to reproduce these results closely.

It will be observed from these results that virtual immunity from trouble due to this cause could be obtained by so ordering affairs that no appliance could be subjected to a change of more than ten divisions. This could be brought about in two ways: if it is customary for all appliances to be adjusted by the fitter on the job, then the overall variation would have to be kept to ten divisions, since it would be impossible to say at what part of the range the appliance had been initially adjusted. If non-adjustable burners are employed, however, a variation of at least ±10 would be permissible, providing that all appliances were designed to work on an agreed mean figure, about which the variation in the gas quality took place.* This provides an additional argument for the desirability of fixed injectors—*i.e.*, it makes a wider variation in the methods of manufacture tolerable. It is probable that many Undertakings do not conform to the limits suggested above, and they may be expected to experience a considerable amount of trouble in consequence without it being recognized as being due to this cause. If a gas fire, for example, were to fail to light up properly soon after it had been installed, the tendency would be for blame to fall on the fitter who had adjusted it; and, conversely, the fitter would probably learn to set similar fires to a rather softer flame than official instructions recommend in order to avoid a repetition of the experience.

Possibly a more serious case would arise in the event of an increase in A.T.B. Number after the appliance had been adjusted; since in this case no actual complaint might be made to the Gas Company although the appliance was no longer giving satisfactory products of combustion. In these circumstances, the user would be apt to gain the general impression that gas was smelly or gave one a headache, without realizing that the appliances needed re-adjusting to compensate for the change in gas quality. In short, variations in the A.T.B. Number of town gas have, unless they are kept within suitable limits, the general effect of depreciating the value of service which the Gas Industry can give its consumers.

Effect of Change of A.T.B. Number on Completeness of Combustion.

One of the most useful features of the test burner as a measure of the combustion characteristics of gas is that it enables combustion tests on appliances to be made even though the actual gas on which they are finally to be used may be hundreds of miles distant. Experience shows, however, that while equal A.T.B. gases will, under some circumstances, give equal CO/CO_2 ratios, the matter has to be approached with some circumspection. So far as our knowledge goes at present, roughly equivalent CO/CO_2 ratios are always obtained if the high A.T.B. Number gas

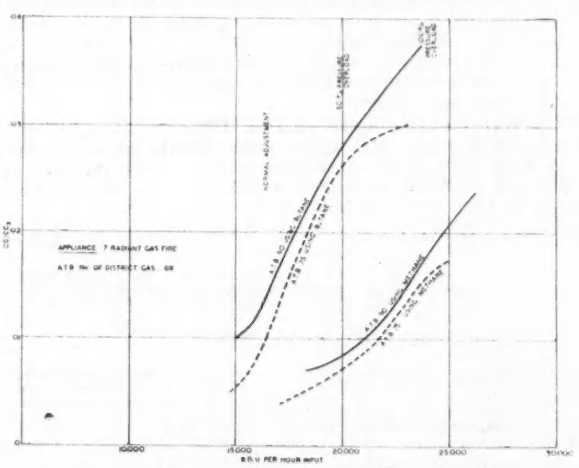


Fig. A.—The Effects of "Softening" Gas by the Addition of Methane or Butane.

is obtained by adding methane to district gas; if other gases are used the results will be less satisfactory. A typical example of this is to be seen in Figure A, where the effects of "softening" gas by adding methane or butane are compared at normal rate, and at 50 per cent. and 100 per cent. pressure overload. It will be seen that butane gives results 2-3 times as high as those obtained with methane; while Figure B obtained with a similar appliance indicates that a reasonable degree of agreement is to be found between "naturally soft" gas and gas

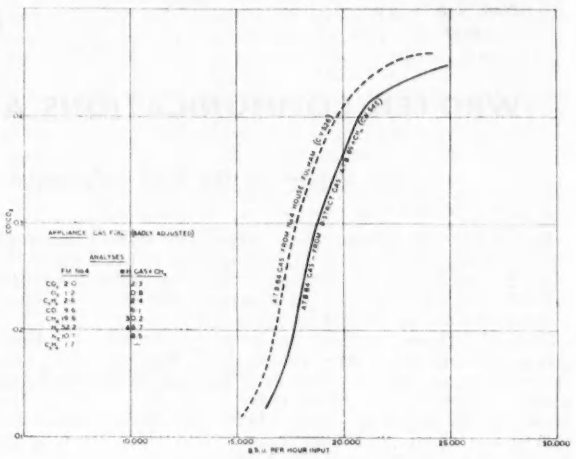


Fig. B.

which has been "artificially softened" by the addition of methane. This difference between the behaviour of methane and butane is unfortunate, since not only is butane much easier to obtain but it has the other advantage that it raises the calorific value of the gas much less (for a given rise in A.T.B. Number) than does methane. Indeed, in the latter case, it is normally necessary to correct for the increased calorific value of the "softened" gas; it will be observed that Figures A and B are plotted on a B.Th.U./hour ordinate rather than cu.ft./hour for this reason.

Can Appliances be Designed to Withstand Wide Changes in A.T.B. Number?

While every effort should be made by an Undertaking to keep the A.T.B. Number of the gas it supplies as constant as possible, something can also be done by ensuring that new appliances are as little susceptible as possible to changes in the combustion properties of gas. This is in essentials a very simple matter; all one has to do is to ensure that a given change in cone height will do the least possible harm. For example, an appliance which normally operates with a burner cone only 1½ diameters in height is likely to give trouble unless some grid is provided to split up the cone if the flame velocity should become too high. A doubling of the flame velocity will approximately halve the cone area; and this will bring the cone height down to 0·75 diameters or less, at which it will almost certainly backfire. If, however, the cone height had been 2½ diameters at normal adjustment, it is clear that little trouble would have been caused; and a simple way of making an appliance burner less susceptible to faulty operation resulting from a "hardening" of the gas is to increase the ratio of height of cone to diameter of base. This need not necessarily involve any fall in aeration, although it may involve re-designing the burner to give a higher burner port velocity. Possibly the best and simplest method of making the alteration is to substitute a group of small holes for one large burner port of similar area. Even though the resultant flames may coalesce into one large inner cone not widely different from that produced with the single hole, a "hardening" of the flame will cause the cones to separate again when, had a single burner port been in use, lighting-back would probably have occurred.

A similar train of reasoning can be applied to designing appliances which shall be resistant to a "softening" of the gas, although in this case an alteration of the cone height produced simply by closing the air shutter does not give the same CO concentration in the products of combustion as would have been obtained had the cone lengthened as a result of change in gas quality. If it is required to forecast this, methane must be added to the gas, as described above. In general, it is difficult to make an appliance insensitive to increase in A.T.B. Number without to some extent reducing the efficiency.

Relation between Nature of Appliance and Change in Cone Height.

When this problem of testing appliances for use on different grades of gas was first considered, it was thought

* That is, if variation be from 60–80, the appliances must be made to work normally on gas of 70 A.T.B.

that the obvious step was to find what proportionate change in cone height corresponded to a given change in the A.T.B. Number. Thus, if a burner were to be examined on a gas of A.T.B. No. 60 it would, it was hoped, be possible to say that on gas of A.T.B. No. 80 the cones would have been x per cent. longer, x being read from a curve or table. An attempt was made to plot "change in A.T.B. Number" against "percentage change in cone height"* (deduced from the flame velocity curve and specific gravity by assuming an air/gas ratio of 2·5), and a curve produced which, in spite of very considerable spreading of the points, showed a very rough relationship (Figure C). When, however, the curve was used to predict change in the cone heights of flames on actual appliances, it was soon found to be very inaccurate. Recently an experiment was made in which four burners were tried first on one gas "h" (A.T.B. No. 57) and then on another gas "s" (A.T.B. No. 93) and the ratio of the cone heights measured in each case. As will be seen from column 5 of Table C, the ratio varied from 1·6 to 2·6 according to the type of burner.

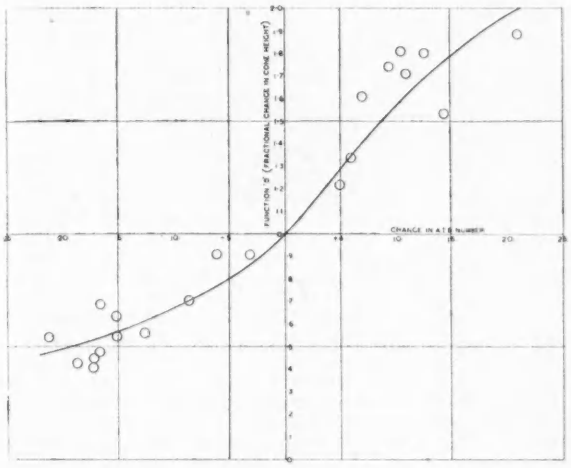


Fig. C.

TABLE C.—*Changes in Cone Height with Various Appliances.*

Appliance.	A/G at Sp.Gr. 0·43.	Slant height of Cone.			Vh/Vs (From Fig. D).
		Gas h.	Gas s.	s/h	
1	2	3	4	5	6
G.L.C. cooker (boiling burner) ..	2·24	0·57	0·92	1·61	2·33
High beam fire ..	3·08	0·42	0·84	2·0	1·9
Lighting burner ..	2·88	0·62	1·38	2·23	2·27
Aeration test burner (set to 60) ..	2·55	0·66	1·72	2·6	2·57
Aeration test burner (set to 57) ..	2·43	0·77	1·95	2·53	2·50

Characteristics of Gases.

Gas.	Origin.	A.T.B. No.	Sp.Gr.	C.V. (est.).
s ..	Town gas + C_4H_{10} ..	93 ..	0·455 ..	510
h ..	Town gas + CO ..	57 ..	0·468 ..	485

It will be observed that the last two lines of the table refer to the use of the A.T.B. considered as though it were an appliance; first arbitrarily set at 60, and in the second case set at 57, which is the A.T.B. Number of the gas "h." Column 2 shows the air-gas ratios at which these appliances were working, as experimentally determined on a gas of specific gravity 0·43. There is no immediately apparent relation between the ratio of cone height and the air-gas ratio; but an experimental plot of the approximate flame velocity curves* of "h" and "s" (Figure D) satisfactorily reveals the relationship. Taking three of the burners from Table C, the vertical arrows show the points on the curves at which each of the burners would operate, allowing for the displacement due to the differences in specific gravity. The ratio of the flame velocities on the two gases for each of the burners has been included in the table (column 6) and it will be seen that in four cases out of five there is a reasonable agreement between

$$\frac{\text{slant height "s"}}{\text{slant height "h"}} \text{ and } \frac{\text{flame velocity "h"}}{\text{flame velocity "s"}}$$

It is, of course, to be expected that the cone height and flame velocities will be in the inverse ratio, since the slant height is proportional to the area of the cone, and the area of the cone is inversely proportional to the flame velocity. The rate of efflux of the air-gas mixture from the ports is, in this particular case, sensibly constant and can be neglected.

This operation is, of course, almost equivalent to the derivation of "Function D"* for the two gases, except that if this had been the intention the adjustment air-gas ratio would have been taken as 2·5, as a representative figure for appliances in general, and corrections made for variations in the rate at which air-gas mixture flows.

In the case of these two gases "Function D" can be evaluated from Figure D. For the transition from gas "h" to gas "s"

$$_hD_s = \frac{(2{\cdot}5 + 1{\cdot}01) \times 37}{3{\cdot}5 \times 15} = 2{\cdot}47$$

which is of the same order as the figures in columns 5 and 6 of Table C. It is probably less near to these than would normally be the case because all the air-gas ratios are rather higher than usual on account of the appliances having been specially adjusted to burn normally on the slow-burning gas "s."

Limitations to the Use of the A.T.B. Number.

It will be seen that the foregoing section to some extent strikes at the theoretical basis of the Aeration Test Burner as a criterion even of similarity. The A.T.B. Number is called upon to express the difference between two flame velocity curves; and naturally a single number can only express the effects of the shape of a curve to a strictly limited extent—*i.e.*, so long as the curves are similar in character. An extreme case of the failure of the A.T.B. Number is illustrated in Figure E, in which the two gases from Figure D have been re-plotted, with the addition of a third hypothetical slow-burning gas "t." Further, curves have been drawn to show the flame velocity and air-gas ratio at which the adjustment point on the standard burner is attained, (*a*) with the standard cone height as at present adopted, and (*b*) with 50 per cent. greater cone height than usual. The A.T.B. Numbers marked on these curves were obtained from a knowledge of the aeration curve of the test burner on gas of 0·45 specific gravity. The intersection of the flame velocity curve with the A.T.B. curve (*a*) shows the conditions (air-gas ratio, flame velocity) under which combustion in the cone of the test burner flame occurs and, with some allowance for experimental errors, this agrees with the measured A.T.B. Number of "s" and "h."

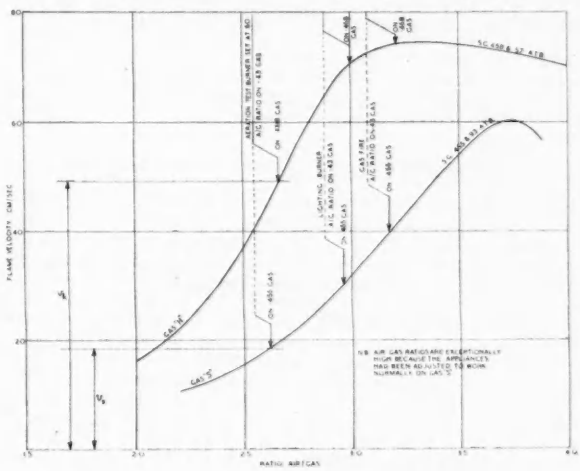


Fig. D.

Now so long as the gases "s" and "h" only had to be compared, the A.T.B. Number was a tolerably good index of the type of flame to be expected on an appliance; but if the gas "t" be considered, it will be seen that the A.T.B. Number might then be almost useless. At present, it has the same A.T.B. Number as gas "s," but if the arbitrary cone height of the test burner were changed it would become different. Although the test burner indicates similarity between "s" and "t," their performance on an appliance working at an air-gas ratio of 2·3 or 3·5 would be noticeably different, and the value of the A.T.B. Number even as an indication of similarity will have greatly depreciated. It is, however, necessary to point out that this difficulty would never be likely to occur if gases of com-

* Actually, "Function D."

† Measured as described by J. W. Wood on p. 81. Bunsen cone assumed to be a geometric cone.

* See p. 64.

mercial origin and similar C.V. were under comparison; but it is clearly desirable that the limitations of the test burner as well as its great potentialities should be realized at the outset. For a really reliable estimate of the combustion characteristics, it is still necessary to measure the flame-velocity curve and the specific gravity of the gases, and then compute the "D. Function"; modifying it if necessary to take into account the air-gas ratio of the particular appliance under consideration.

Correlation of Gas Composition with A.T.B. Number.

One of the principal gaps in our knowledge of this subject at present is that there is scarcely any answer to the question, "What causes the A.T.B. Number to vary?" or, more precisely, "How is the A.T.B. Number lowered by, say, 10 units?" This problem is of such importance that it may be of interest to describe an attempt which has been made towards correlating gas composition and A.T.B. Number. In the absence of any known mathematical relationship between the composition of a mixture of five or more gases and its flame-velocity curve, it appears that a graphical method is the only one likely to prove practicable. Such a method is illustrated in Figure F, which shows the first diagram to give anything like consistent results. On it has been plotted the composition of a number of samples of town gas,* each represented by a number, which is the A.T.B. Number of that particular sample, while the position inside the triangle indicates the analysis. The difficulty of representing a gaseous mixture containing at least seven major constituents would, at first sight, appear insuperable; but, in fact, the number of independent variables can be cut down from six to three by the following steps:

(*a*) Group O_2 N_2 and CO_2 as one gas — "inerts."

(*b*) Assume all mixtures to be of the same calorific value. (This has the effect of removing one variable.)

The three independent variables left can then be represented on a series of two-dimensional triangular diagrams or on a single triangular prism formed by the superposition of the triangular laminæ one above the other.

In the present attempt, "inerts" have been thought most suitable for the vertical axis—*i.e.*, each two-dimensional diagram has a fixed percentage of inerts—in the case of the example shown, 14 per cent. The corners of the triangle are occupied, not by single gases, but by equi-

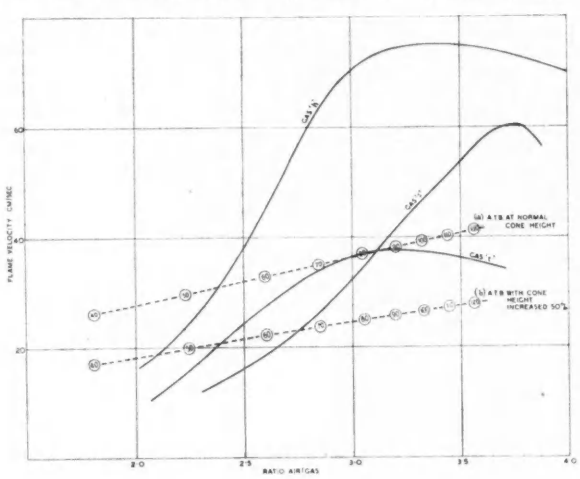


Fig. E.

calorific value mixtures; from which it follows that every point inside the triangle must have equal calorific value, and in practice the corners can be so chosen that every likely mixture falls within the triangle. In order, however, to simplify the use of the diagram, ordinates have been added for each of the components singly, and by means of these the diagram can be used even by those who are not familiar with triangular diagrams. Thus, the point A can clearly be seen to represent the following gas:

14 per cent. inerts } 500 B.Th.U./cu.ft. }	common to whole diagram.
C_nH_m	4 per cent.
CO	8½ "
CH_4	21½ "
H_2	52½ "

The general consistent drift of the points is sufficient to promise more precise information when more results have been collected. Contours have been drawn provisionally for test burner numbers of 65, 70, 75 and 80, in order to show the general trend, but they should not be accepted without reservation.

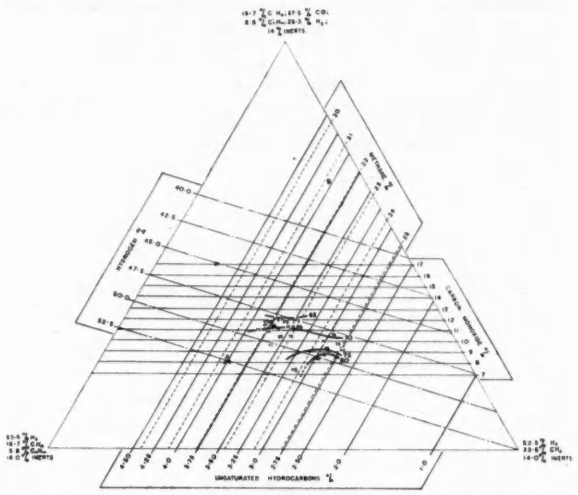


Fig F.—Relation Between Gas Composition and A.T.B. Number.

Further diagrams corresponding to 12, 10, and 8 per cent. inerts (but restricted to 500 B.Th.U./cu.ft.) are in preparation. When this has been done, it will be possible for any engineer to see what the effect of changes in manufacturing methods is likely to be on the A.T.B. Number. For example, keeping within the range of this diagram, a change from A.T.B. No. 65 to 80 would be made by decreasing carbon monoxide from 12½ per cent. to 8½ per cent., increasing methane to 25 per cent., hydrogen to 50 per cent., and decreasing unsaturated hydrocarbons to under 3 per cent. This would mean that the inerts would remain 14 per cent., which might well prove difficult in practice; when the three-dimensional diagram has been prepared, this difficulty will be overcome, and it should then be possible for the Works management to manufacture gas at any A.T.B. Number, or range of numbers, considered desirable.

A Wise Decision.

Dr. C. M. Walter (Birmingham) wrote: The decision of the Joint Research Committee to devote the first twelve months of this work to a critical survey of the literature relating to the Combustion Characteristics of Town Gas was undoubtedly a wise one, and from the Report which is now presented it is clear that a great deal of research work will yet have to be carried out, in order that the knowledge which has so far been acquired in this connection may be applied.

Reference is made in the Summary to the fact that burners of the atmospheric or Bunsen type are those most noticeably affected by the change in the combustion characteristics of the gases employed. It may be mentioned that for industrial purposes the atmospheric type of burner is, at the present time, used to a much greater extent than is generally appreciated, particularly where the heat requirements are such as not to demand a high thermal concentration; thus, in heat treatment operations where temperatures not exceeding 900-950° C. are required, the atmospheric burner is invariably employed, owing to its simplicity and to the fact that no auxiliary plant, such as air compressors, are necessary.

In Birmingham, we have large numbers of furnaces of all types used for heat treatment, and it would be safe to say that not less than 60 per cent. of these operate with atmospheric burners, requiring gas at ordinary town pressures.

Whilst there is little doubt that the increase in demand for the atmospheric type of furnace is to some extent due to the considerable improvements which have taken place during recent years, it must be realized that a great deal of experimental work is yet to be carried out in order to cater for the requirements of industry, which are continually becoming more exacting.

Recent developments in connexion with automatic control of the temperature and the furnace atmosphere demand a system of burners which will at the same time provide a constant aeration over a wide range of gas consumption, and a furnace atmosphere of uniform and unvarying composition. In order to meet these require-

* Provided by Mr. H. Hollings, Chief Gas Chemist, Gas Light and Coke Company.

ments a wider knowledge of the combustion characteristics of the fuel is essential if the technique of burner design is to be improved.

On page 22 reference is made to the effect of inerts on flame-speed. The effects of inerts in regard to the retardation of flame-speed are clearly illustrated from a study of the end of the combustion period with closed vessel experiments, and it is very important that careful consideration should be given to the question of period required to effect complete combustion with varying percentages of inerts, and at the same time correlate this with thermal concentration.

In many types of industrial appliances the degree of thermal concentration is dependent on the percentage of inerts present in the gas, and it is of great importance that the combustion chambers should be designed in relation to the thermal concentration available.

With regard to the rate of flame propagation in Bunsen flames working in closed chambers, it will be realized that although the conditions under which combustion takes place in closed vessels are not comparable with the conditions applying to the open combustion chamber—the former being at constant pressure and the latter at constant volume—there is little doubt that the experiments conducted in closed vessels have led to a considerable increase in our knowledge of the mechanism of combustion. As an example, the researches into the combustion of CO-air mixtures have shown conclusively that combustion takes place in three distinct stages, as indicated by the breaks in the pressure-time curves. Further, the influence of dissociation on the rate of combustion can, by this means, be closely studied. Perhaps some further attention will be given to this part of the subject during the further work which is to be undertaken.

With reference to the effect of preheating on flame velocity, it is evident that flame-speed will increase with preheat when one considers that, in reality, what takes place is in the increase in temperature of the adjacent layer of the charge up to its ignition temperature. It is thus evident that the flame-speed is related to the specific heats of the gases. From this consideration it would be anticipated that at the higher temperatures, particularly, the flame-speed would have increased to some power of the absolute temperature. With regard to flame radiation, the influence of radiation on flame-speed is very important in certain heat treatment operations, particularly where there is a tendency for stratification of the mixture. On page 30 reference is made to the curves in Figure 19 correlating flame-speed with mixture strength for different gases. This information is undoubtedly very useful in connexion with the practical design of burners. There are, however, many other factors which influence the tendency of back-firing, and I entirely agree with the Authors that there is need for further experimental work on this subject. It would appear that whilst the flame-speed curve gives information to the designer of burners, I do not see that it can be considered a satisfactory means of determining the quality of the gas.

With regard to the reference on page 34 to the aeration of burners and types of orifices, I would like to emphasize the importance of the correct centring and the alignment of jets relative to their venturi. If the alignment is incorrect, eddies are set up in the region of the injector throat which materially interfere with the efficiency of the injector and so considerably reduce the entrainment of air.

With reference to the standard air-gas ratio obtainable with properly designed injectors, it may be mentioned that in many industrial furnaces it is often necessary to have constant air-gas ratio over a wide range of gas consumption, and it is of great interest to note that if the air-gas ratio falls slightly as the gas rate is reduced the inner cones will remain at a satisfactory length and the burner can have a wide range of turn down without risk of back-firing. It must be borne in mind, however, that in practice with many appliances the resistance set up to the flow from the burner tube is so great that the mixture velocity is considerably reduced. This can to a considerable extent be eliminated if careful attention is paid to the design of the burner. It can generally be stated that one of the essential parts in any gas burning apparatus, whether industrial or domestic, is the burner itself, and there is little doubt that much more attention must be paid to the scientific design of injectors, of both single and multi-stage types in order to obtain the best possible results.

The further study of the transformation of the kinetic energy of the stream of gas at the jet into pressure differences whereby the primary air induction takes place is a subject in which much experimental work has yet to be carried out.

In conclusion I would like to congratulate the Authors on the very thorough and comprehensive manner in which they have collected and reviewed the published information, which will undoubtedly be used by all those who desire to increase their knowledge of this most important subject.

Mr. C. A. Masterman (Gas Light and Coke Company) wrote: As one partly responsible for the initiation of the work covered by the 40th Report, I would like to confirm Mr. Evans' reference to it as part of a long term plan. There is little doubt that he is correct in looking forward to a future when gas composition may change considerably compared with the present day, owing to increased demand for gas and change in relative demands for gas and coke.

Consumers demand an ever-increasing standard of heat service, and it would be intolerable if progress in other directions led to an increase in number of noisy burners, appliances lighting back, and the like. In the long run these must necessarily dictate the type of plant and manufacturing process used.

The object of Mr. Wood's work is to anticipate such troubles and point the way to avoiding them. It is of vital importance that the fullest knowledge be made available to the designers of gas appliances on the one hand, and those responsible for manufacturing and distributing gas on the other. Hitherto, we have even been without a method of measuring these combustion characteristics in any quantitative way.

The work requires the co-operation of the whole Gas Industry. Whereas at Leeds the fundamentals of the problem are being attacked, the Gas Industry has now available in the Aeration Test Burner an instrument, not of scientific precision, but capable of acting as a rough criterion of the satisfaction or dissatisfaction of the consumer. It is hoped that as soon as possible numbers of these burners may be in use both by Gas Undertakings and by appliance manufacturers. As a result of this, a rough check may be obtained on the one hand of the range over which various existing appliances will operate satisfactorily, and on the other hand of the type of changes which should be anticipated in gas composition on the district and their effect on appliances in terms of consumer service.

Clearly this is work which should not be done in a laboratory, nor responsibility for which the workers at Leeds University should be asked to bear. We want from them only their views on the test burner as now produced, its limitations, precautions to be exercised, and modifications to be recommended.

While the Gas Industry by its use can be gaining information of vital importance to itself, the research workers at Leeds will be carrying further their long term research on the fundamental problem of what it all means and so, one hopes, gaining information vitally necessary for the ultimate solution of this very practical problem.

A.T.B. Design Not Entirely Satisfactory.

Mr. W. E. Benton (Bilston) wrote: I congratulate the Authors on their clear exposition of the literature on this subject. The summary and bibliography will be invaluable to those engaged on work connected with the combustion of gas. I would like to comment on the second part of the Paper which deals with the Aeration Test Burner. Although I have used this burner for some little time and find it useful in laboratory work, I do not think that its design is entirely satisfactory. I think it is a mistake to stipulate streamline conditions of flow, and a burner designed as a standard should not have a positive pressure at the choke. The vertical height of the burner is also an unnecessary complication, as it introduces a small lifting force which varies with the density and aeration. The resistance of the burner is also too high.

In nearly all aerated burners the condition of the mixture is turbulent. Far from being a handicap, turbulence in the gas leaving the injector and in the burner mixture is necessary to obtain quick entrainment and good mixing. One of the functions of the perforated steatite disc which we fit below each flame of a gas fire is to sieve the mixture and release it in a state of fine turbulence. In this way we obtain a practically uniform velocity across the burner port, with the result that the inner cones are rectilinear except for the slight rounding at the apex. As the Authors point out, the calculation of flame-speed from cone height depends on the assumption of this uniform velocity. In the Aeration Test Burner Reynold's Parameter is in the neighbourhood of 1,000 and the length of the burner is more than twenty diameters, which is sufficient for the attainment of viscous flow. There is a parabolic velocity gradient across the tube, which shows itself in the shape of the inner cone, and also accounts for the initial curvature of the aeration curve (Figure 30). In viscous flow the coefficient of resistance falls very steeply as the velocity is increased towards turbulence. Hence the resistance of the tube will be proportionately less, and the aeration of the burner will rise more steeply with each increment of the total flow; in other words, the curve of aeration

will bend upwards as the shutter is opened. But the shutter and the burner represent in effect two resistances in series. As the shutter is opened its resistance falls until it is the less important of the two terms of the total resistance. The aeration curve will, therefore, reach a maximum gradient (or a point of inflexion) when it will start to bend the other way with a decreasing curvature until further opening of the shutter produces no further increase in aeration. It is clear from Figure 30 that the resistance of the burner is too high in proportion to the resistance of the shutter. A burner of half the length, expanded from the choke and fitted with a perforated disc below a suitable orifice, would have a lower resistance and would give a cone of better shape, one which would, I think, more accurately assess the combustion characteristics of a manufactured gas.

Incidentally, I think the phenomenon of lighting back, described by the Authors in the first part of the Paper, is a function of the velocity gradient across the burner port. A flame does not strike back in the centre, but at the edge.

At an aeration of 3·0, this burner tube offers a resistance of 0·02 cm. of water. Since the tube is of uniform cross section, this resistance can only be overcome by the existence of a positive static pressure of 0·02 cm. at the choke. This is undesirable in a standard burner, as it makes the aeration dependent on the shape of the approach to the choke and on the position of the jet. Partly counterbalancing this choke pressure is the lifting effect due to the density of the mixture in a vertical tube of such a considerable length. This lifting pressure amounts to 0·0060 cm. of water when the density is 0·4, 0·0047 cm. at 0·5 and 0·0034 cm. at 0·6.

I think that in a standard burner the mixing tube should preferably be horizontal, connected by a suitable elbow to a vertical port. With these alterations I think the accuracy of this useful instrument would be materially increased.

Fixed Air Inlet.

Dr. A. E. Haffner (Gas Light and Coke Company) wrote: If the purpose of a test burner is to provide a comparison of the cone-forming properties of different gases, the simplest method is to use a test burner of fixed air inlet. To adopt a variable air inlet in the test burner is to add a further instrumental factor—the relationship between air shutter opening and amount of injected air. This relationship is not linear, and at high values considerable movement of the air shutter has a comparatively small effect.

In discussing the application of the Hofsäss burner as a test burner, the Report doubts that a single instrument could be used under the same standard conditions without experiencing lighting back or blowing off. In the course of experiments carried out at the Gasinstitut, Karlsruhe, in connexion with the Arthur Duckham Research Fellowship, a simple Teclu burner of fixed air port was found to have the cone heights recorded for the following gases:

—	Cone Height, cm.	A.T.B. No.
1	2	3
Coal gas 560 B.Th.U./cu.ft. . .	16·5	220
Coal gas + b.w.g. 500 B.Th.U./cu.ft. . .	9·6	73
Coal gas + b.w.g. 450 B.Th.U./cu.ft. . .	3·0	54
C.w.g. 450 B.Th.U./cu.ft. . .	1·2	40

With straight coal gas the cone could still be measured and with c.w.g. (450 B.Th.U.) the burner was on the point of lighting back. According to Mr. Stewart's Paper on the "Changing Influences in Gas Manufacture" this range of gases covers 95 per cent. of British town gas. Although in this range the burner did not fail due to lighting back or blowing off, the objection still remains that if the air-gas ratio in the burner is a suitable one for 450 B.Th.U. gas mixtures, it may correspond to an unsuitable part of the ignition velocity curve for 500 B.Th.U. gases.

The Report contains the conclusion that the Keunziffer of Czakó and Schaak has no advantage over the test burner value. Schaak himself in his recently published dissertation comes to the same conclusion.

The Report describes the Dommer apparatus for the determination of ignition velocity-composition curves, but it appears that complete information was not available. The apparatus uses a 5 mm. burner, a mixture velocity of 41·5 c.c. per sec., and the ignition velocity curve is recorded on a chart about 10 in. × 8 in. The difficulty of continuously following the changing cone height is overcome by practised operators, but the rapid change of ignition velocity with change in air-gas ratio makes it essential that there should be exact correspondence between the composition of the burning mixture and the position of the recording drum. Any time lag due to instrumental or observation errors is a source of great inaccuracy, and Bruckner has preferred a stepped instead of a straight separation wall in the proportioning chamber, in order to provide a better opportunity of carefully measuring the cone height corresponding to a given air-gas ratio.

The Report will be of considerable value to the increasing number of investigators interested in the combustion characteristics of town gas.

The Wobbe Index.

Mr. D. M. Holloway (Birmingham) wrote: Before dealing with the subject matter of this Report, I should like to add my appreciation of it as a whole to those that have already been expressed.

As a review of the existing data in connexion with combustion characteristics, the first part of the Report will be invaluable for reference purposes and the work carried out in connexion with the Aeration Test Burner will be very helpful to those like ourselves who are commencing to employ this instrument.

Among the various criteria which are mentioned in the Report, there is one, the Wobbe Index, the advantages of which seem to me to have been somewhat under-estimated. While this is not sufficient, any more than any other single index, as a sole criterion of gas quality, it appears to have advantages for the control of thermal input over the calorific value which is normally used for this purpose. A particular respect in which it shows a great advance is one which is closely related to combustion characteristics, namely, the initial adjustment of appliances. It is, I think, universally acknowledged that the use of fixed injectors conveys many considerable advantages, and the only thing which has retarded the adoption of fixed injectors more extensively is the difficulty of assigning correct values when, as is normally the case, the calorific value is the only constant characteristic of the gas. Personally, I consider that the advantages of fixed injectors more than outweigh the difficulties inherent in classifying injectors on the basis of C.V. alone, and considerable experience of supplying fixed injectors on this basis has confirmed this view. Anomalous cases do arise, however, where abnormal specific gravities are met with, whereas if the Wobbe Index for the gas had a known and constant value the correct injector to give the rated output could be assigned with complete certainty. From other points of view the Index has advantages over the calorific value, *e.g.*, in many cases it is more convenient to omit a volume measuring device and sell gas on a time basis as is done with street lighting installations. This procedure is strictly justifiable when a constant Wobbe Number and therefore a constant heat input is maintained. It is not practicable, of course, to eliminate completely the measurement of calorific value since this is required as the basis of charging for gas sold, and it is suggested that one should work to a constant Wobbe Index, allowing the C.V. to vary, and then base charges on the average C.V. for the period. I have not sufficient knowledge of Gas Works practice to say whether it is any more difficult to control to a constant Wobbe Index than to a constant C.V., but the design of control instruments would, on the face of it, appear to be simplified. So much for the main claim of the Wobbe Index—constancy of thermal input.

As I stated at the commencement, I do not think a claim that it should be regarded as a sole index could be justified, but I do think that with a constant Wobbe Index less variation in combustion characteristics will occur than with a constant C.V. Some support for this statement can be obtained from an examination of the American Gas Association's "C." Factor.

It is pointed out in the present Report that the "M" term in this Factor accounts for over 97 per cent. of the variation with normal gases and therefore is the only term of real importance. This term assesses combustion characteristics on the basis of the quotient, thermal input / primary aeration $\left(\frac{I}{P}\right)$, the latter being expressed as a percentage of theoretical requirements.

It is shown that $\frac{I}{P}$ is proportional to $\frac{hA}{d}$, where h is the calorific value, A the air requirement of the gas, and d the density. Now it is well known that over a fairly wide range the air requirements of a gas are roughly proportional to its calorific value (*e.g.*, of the gases given on p. 71 of the Report the middle six, covering a range of calorific values from 392-583, fulfil this generalization with a mean deviation of less than 4 per cent.). If, therefore, the air requirements in the above expression are assumed proportional to the calorific value, $\frac{I}{P}$ becomes proportional to $\frac{h^2}{d}$ which is the square of the Wobbe Index, and

therefore will be constant as long as the index is maintained at a given value.

In view of the above facts, I consider that standardization of the Wobbe Index, instead of calorific value, would represent a definite step forward, although I certainly agree that subsidiary control such as can be obtained from the Aeration Test Burner, or other criterion, is desirable in addition.

Disadvantages of the Teclu Burner.

Mr. H. J. HODSMAN (Leeds University) wrote: The test burners hitherto used appear to be elaborations of conventional burners—especially the Teclu, although there does not seem to be any reason for this limitation. The problem fundamentally is to control the supply of air to a burner by means of a graduated and strictly reproducible aperture. The Teclu air shutter does not seem an ideal arrangement. The air is admitted by what is in essence a rectangular aperture with a maximum effective short axis of 1/32 in. Adjustment is made along this short axis, whereas it would be more rational to control via the long axis of an aperture. As a consequence great precision in construction is demanded, and this is seen in an extreme form in the Czakó and Schaack burner. The permanence of the calibration of the burner depends on the accuracy and durability of a fine thread.

I have attempted to meet this difficulty in a burner with an injector enclosed in a box to which air is fed by a slot-shaped valve of a design found useful in our laboratories. The control of air is made by varying the long axis of a rectangle and no dependence is placed on screw threads. There is no reason why calibration should alter by wear. Mechanically it seems satisfactory, but I have no results yet available. If it proves to have advantages, they will be mechanical only and will not alter Mr. Wood's general conclusions.

Collection of A.T.B. Data Desirable.

Mr. S. E. A. RYDER (Liverpool) wrote: I wish to offer my congratulations to the Staff of the Joint Research Committee for the bibliography which they have prepared and also for the review of the existing literature relating to the problems of combustion characteristics.

With regard to the practicability of the general employment of an Aeration Test Burner, there is, at present, considerable doubt as to whether or not a single reading taken on such a burner will give a sufficient indication of the combustion characteristics of the gas. There is evidence that gases of similar calorific value and giving the same A.T.B. Number can give different results when burned in an appliance, particularly in regard to the CO/CO_2 ratio of the products of combustion. We have encountered this point in work on domestic cooker boiling burners. There is also need for data as to whether the figures obtained with an Aeration Test Burner will give a guide to the behaviour of a gas in any form of aerated burner or whether such figures would only be applicable to certain types of burner and possibly over a limited range of primary aeration.

The Aeration Test Burner appears to be the most suitable apparatus in a sufficiently simple and robust form, suitable for general use, which is at present available and certainly warrants further investigation. The principal need appears to be for more data on the relations between cone height, calorific value and gas composition.

Mr. Wood and his collaborators have suggested, on p. 74 of the Report, that a greater standard cone height would be an advantage, but it would be unwise to make such a change on the limited number of gas mixtures so far investigated.

There are a number of Aeration Test Burners now in use in various parts of the country, all of which have been calibrated against a master burner. If each of the observers using an Aeration Test Burner would furnish to the Joint Research Committee details of Aeration Test Burner Number for, say, 14, 19, and 25 mm. cone heights, composition, observed calorific value and specific gravity of the local town gas, these results could be correlated and would give an idea of the range of A.T.B. readings to be expected in practice, the best standard cone height for general use, and whether one standard burner is sufficient for the range of gases to be covered.

Data collected in the manner suggested above would probably serve as a more useful guide than results obtained with synthetic mixtures.

Mr. Wood's Reply.

Mr. J. W. WOOD, in reply, wrote: The discussion of the Report extends to such a length that it will be more convenient to give a summarized reply than to deal in detail with individual contributions.

The importance of understanding and controlling combustion characteristics as a means of securing a greater measure of service to the gas consumer has been stressed by several speakers, notably Dr. Hartley, Mr. Masterman, and Dr. Walter. At the same time doubts are expressed as to the possibility of indicating the combustion characteristics of a gas by a single numerical value, especially when one bears in mind the multifarious conditions under which gas may be burned. There is also no consensus of opinion as to whether the property assessed should be essentially a property of the gas, or to what extent the design of the burner should be allowed to contribute to the final result.

The proposal to use a carefully standardized Bunsen burner as a test instrument seems on the whole to be acceptable. Evidence submitted by Dr. Hartley and Mr. Minchin suggests that irregularities may be encountered if the nature and quantity of the hydro-carbons in the gas are extensively modified, but these features, while interfering with the scientific precision and interpretation of Test Burner Numbers, should not greatly detract from the value of the test burner as a practical aid to securing uniformity of combustion characteristics under normal carbonizing conditions.

The Aeration Test Burner is still under examination and the suggestions put forward by Mr. Benton, Mr. Hodsman, and Mr. Hawes regarding its design and use will be carefully considered by the Committee, as will also the suggestions for the collection of data relative to the variation of the Test Burner Number of gases now distributed throughout the country.

Mr. Holloway considers that the merits of the Wobbe Index have been under-estimated. Apart from the legal questions arising, it would be more difficult in practice to maintain a composite quantity like the Wobbe Index constant than to maintain the calorific value constant. Nearly all Mr. Holloway's points would be met if the specific gravity were voluntarily kept within narrow limits, and if both specific gravity and calorific value were quoted when ordering gas appliances. Some improvement in performance could then be expected, but uniformity of combustion characteristics would not be guaranteed.

It is interesting to hear from Dr. Payman how the "speeds generalization" made its first appearance in the literature of the Gas Industry, and to know of the limitations which he himself would impose upon its application. The very definite statement upon p. 18 of the Report to the effect that there is no simple proportionality between the flame-speed of a mixture and those of its constituents with air was made, not with the intention of suggesting that there was no connexion between these quantities, but to prevent engineers from making what is apparently a reasonable calculation, which as a matter of fact yields an entirely erroneous result.

It would be interesting to know if the rules mentioned by Dr. Payman as applicable to "basic mixtures" of hydrogen and methane have been experimentally verified for other pairs of gases, and for more complex mixtures such as arise in the combustion of town gas, and whether they also apply when there is present an excess of combustible in the mixture, as is usually the case in the primary air-gas mixture in a Bunsen burner.

The same flame-speed data can be correctly represented on both air-gas ratio and percentage composition bases, the choice depending upon the particular purpose for which the figures are being used, and the arguments submitted by Dr. Payman support our contention that a statement concerning "range of usefulness" or "displacement" may be misleading as a generalization if it is not accompanied by some indication or knowledge of the type of curve to which it refers.

Attention is called by Dr. Townend to what may be regarded as the mechanism of combustion, and the special spectroscopic methods which may be necessary for its ultimate elucidation.

Thanks are due to Dr. Haffner for supplementing our information relating to the Dommer flame-speed apparatus. It will be observed that while the A.T.B. Numbers for gas mixtures given by Dr. Haffner are in reasonable accord with those given by Stewart and in the 40th Report, the A.T.B. Number for the coal gas is exceptionally high. That it is possible to burn gases of a wide range of calorific values in a Teclu burner with fixed air adjustment is admitted; it may be questioned, however, whether the inner cones would in all cases be sufficiently well defined to be measured and made the basis of assessing gas quality in a standard instrument.

The contribution from the Watson House Laboratories of the Gas Light and Coke Company under the name of Mr. Minchin is welcomed as an introduction to that part of the investigation of combustion characteristics which we have pointed out is still regrettably weak, namely, the provision of a connecting link between criteria and Test Burner Numbers and the corresponding behaviour of gases

in appliances. It would be premature at this stage to attempt to comment upon its contents in detail.

In conclusion, I should like to thank those gentlemen who have contributed to the Discussion, and to acknowledge the reception accorded to the Report. The general nature of the Report, as a critical review of the existing literature upon combustion characteristics, has been appreciated, and it is gratifying to know that it is regarded as being of service to those having to deal with gas utilization and the problems of the combustion of gases.

41st Report of the Joint Research Committee of the Institution and Leeds University. The Investigation of the Use of Oxygen and High Pressure in Gasification. Part II. Synthesis of Gaseous Hydrocarbons at High Pressure.—Communication No. 167.

Dr. D. T. A. TOWNEND (Imperial College of Science and Technology) wrote: Whatever practical application of the results contained in the 41st Report of the Joint Research Committee on the pressure hydrogenation of semi-cokes may ultimately be possible, all concerned are to be congratulated on a most interesting and sound investigation.

At South Kensington we have always been interested in the various methods of producing methane and particularly in its synthesis from water gas by means of the reactions

(i) $CO + 3H_2 \rightleftharpoons CH_4 + H_2O$
(ii) $2CO + 2H_2 \rightleftharpoons CH_4 + CO_2$

According to both equations methane formation is accompanied by a 50 per cent. decrease in volume of the reactants so that high working pressure is conducive to a greater proportion of it at equilibrium; thus, with reaction (i) the conversion of CO into CH_4 at 750° C. would be somewhat as follows:

10 atmospheres	30 per cent.
100 atmospheres	70 per cent.
500 atmospheres	84 per cent.

For some years past all our methane for research purposes has been made by passing a suitable CO-H_2 mixture over a promoted nickel catalyst at a moderate pressure and at about 300° C.

While the main interest of the Report lies in the discovery that the gasification of a semi-coke is enhanced in a remarkable manner by hydrogen under pressure it is instructive to observe how rapidly, when using the initial mixture

CO_2	12
CO	3
H_2	27
H_2O	58

a state of equilibrium was established in the gaseous products and to consider how their calorific value might be improved in the absence of certain of the gases present, *e.g.*, steam. In attempting this, one is handicapped by lack of information concerning both the exact gas balances and the steam contents of the samples following gasification. Figures are available, however, for the steam decomposed during the last hour of experiment (Table 1) and assuming these to be applicable to Sample (4) it is possible to state the partial pressures of the gaseous constituents leaving the reaction vessel. Thus with the lignite (column 2):

Partial pressure atmospheres of steam leaving the system = 81·6 per cent. of 29 = 23·6.

The partial pressure of other constituents therefore = 50 − 23·6 = 26·4, divided as follows:

CO_2	7·4
CO	3·35
H_2	13·2
CH_4	2·45

From such data the following equilibria have been calculated for samples (4) Table 1:

Remembering that the experimental values may need some correction for compressibility factors the agreement may be regarded as good.

It seems apparent, therefore, that of the methane available from the gasification process that recoverable in the products will depend upon equilibrium conditions at the reaction temperature and pressure unless the time of contact be very short; for this reason when considering the yields from the semi-cokes of various coals it is necessary also to consider the water formation in each case, the data concerning which are not available. Mention may perhaps also be made that the CH_4 yields from the semi-anthracite coke using (*a*) hydrogen and (*b*) the usual mixture, given on p. 15, may be misleading for if with (*b*) the steam content be allowed for, the percentages would be approximately halved.

These matters apart, the results are most valuable, for if a continuous process be visualized its flexibility would be such that the calorific value of the products could be controllable by variation of working pressure, temperature and composition of the ingoing gases. Also, with the assistance of catalytic methane, liberation might be effected at lower working temperatures and the efficiency of the gasification further improved; and in this connexion it is of interest to recall the experiments of Fischer, who found a more efficient hydrogenation using the water gas reaction $CO + H_2O = CO_2 + H_2$ for the production in the medium of a so-called nascent hydrogen.

Professor H. L. RILEY (Newcastle-upon-Tyne) wrote: I would like to call attention to the work of Berl and Bemmann* on the action of hydrogen on wood charcoal and active carbons and the synthesis of methane.

These Authors have shown that in the pressure hydrogenation of wood charcoal, methane, which is practically the only product, is formed with high yield. The reaction is affected by the presence of a nickel catalyst and it is suggested that in this case it proceeds through the intermediate formation of a carbide.

The effect of pressure, temperature, and the nature of the carbon upon the velocity of hydrogenation is reported and the results obtained have an important bearing upon the work described in the Report of the Joint Research Committee.

Mr. H. J. HODSMAN (Leeds University) wrote: One advantage expected from complete gasification is the emancipation from the restriction to a narrow range of high class coal. A process such as the one envisaged in this report would lessen the importance of low sulphur content, but some trouble is expected in dealing with fusible coal. It would be unpleasant to acquire freedom from the re-

* Z. Phys. Chem., 1932, **162A**, 71.

Reaction.	Lignite.	Weakly Caking Yorkshire Coal.	Strongly Caking Yorkshire Coal.	Semi-Anthracite. Best Available Data.*
1	2	3	4	5
$2H_2 + 2CO \rightleftharpoons CH_4 + CO_2$				
$K = \frac{[H_2]^2\,[CO]^2}{[CH_4]\,[CO_2]}$	$1{\cdot}08 \times 10^2$	$6{\cdot}75 \times 10$	$5{\cdot}21 \times 10$	$3{\cdot}76 \times 10$ (° C. 700: $3{\cdot}55 \times 10$; 800: $1{\cdot}95 \times 10^2$; 900: $2{\cdot}35 \times 10^2$)
$CO + H_2O \rightleftharpoons CO_2 + H_2$				
$K = \frac{[CO]\,[H_2O]}{[CO_2]\,[H_2]}$	$8{\cdot}2 \times 10^{-1}$	$7{\cdot}6 \times 10^{-1}$	1·13	1·25 (727: $7{\cdot}18 \times 10^{-1}$; 827: 1·04; 927: 1·41)
$CH_4 \rightleftharpoons C + 2H_2$				
$K = \frac{[CH_4]_2}{[H_2]}$	$1{\cdot}42 \times 10^{-2}$	$1{\cdot}15 \times 10^{-2}$	$1{\cdot}91 \times 10^{-2}$	$3{\cdot}3 \times 10^{-2}$ (727: $1{\cdot}04 \times 10^{-1}$; 827: $3{\cdot}83 \times 10^{-2}$; 927: $1{\cdot}66 \times 10^{-2}$)
$2CO \rightleftharpoons CO_2 + C$				
$K = \frac{[CO]^2}{[CO_2]}$	1·54	0·78	0·98	1·22 (727: 2·09; 827: 1·33 × 10; 927: 6·18 × 10)

Spiers. Technical Data on Fuel. 1935, p. 337.

striction to coking coal only in exchange for a limitation to the use of non-coking coal. Dr. Dent in his experiments has avoided trouble due to fusion by a preliminary carbonization at low temperatures. Pre-carbonization may seem a formidable difficulty owing to the limited applications of low temperature tar in the past. This condition may pass away. Already low temperature tar has acquired a use as stock for hydrogenation. I have pointed out elsewhere (British Patent 471216) that for other uses of tar dependent on high viscosity, low temperature tars are specially suited, if the viscosity is obtained by developing "structural viscosity" instead of by distillation as in current practice. It is even conceivable that road tar may be prepared in this way from low temperature tar. Low temperature tar may in future be in demand. Under these conditions it will be desirable to conserve the liquid products by carbonization prior to gasification whether the coal be coking or non-coking.

Dr. Dent's Reply.

Dr. F. J. DENT, in reply, wrote: We are glad to have the interesting ideas put forward by Dr. King, Dr. Townend, and Professor Riley on the mechanism of the reactions studied in the Report. In the present early stages of the investigation our experiments have not aimed specifically at elucidating the mechanism excepting perhaps experiment 23, which demonstrates the importance of a continued rise in temperature while the coal is undergoing the hydrogen treatment. Since finding that gaseous hydrocarbons could be produced rapidly by the hydrogenation of coals under pressure we have been concerned more with seeking methods for the practical application of the results and, at the moment, we do not feel in a position to expand the general statement on mechanism which is made in the Report. It can be said, however, that so far, the results appear to be in closer agreement with the theories of Berl and Bemmann than with the suggestion that hydrogenation necessarily takes place through unsaturated residues such as $\rightarrow CH$, $> CH_2$, or $- CH_3$. Thus, in the material gasified, the ratio of the amount of hydrogen to the amount of carbon was sometimes less than is required by even a $\rightarrow CH$ residue. For example, whereas hydrogen and carbon are present in a $\rightarrow CH$ residue in the ratio of 1 to 12 by weight, the ratio of hydrogen to carbon in the material gasified from the 800° C. coke (experiment 27) was 1 to 81. It appears that hydrogenation occurs at unsaturated carbon atoms or groups which originally are not invariably combined with hydrogen.

The results of Berl and Bemmann are particularly interesting in showing that, with the material they used, viz., charcoals and active carbons, hydrogenation to gaseous hydrocarbons occurs comparatively rapidly at temperatures as low as 500° C. In contrast, we have found that bituminous coals require a higher temperature, the rate of reaction continuing to increase up to 700-750° C., temperatures at which it might have been supposed that the solid residue would have assumed an unreactive form. It may be stressed that, at these high temperatures, high yields of methane are obtained from all types of coal and are not in any way dependent upon the use of specially active carbons. There is clearly much material here for further investigation.

In reply to Dr. King's remarks on the start of methane production shown in Figures 1 and 5, it should be pointed out that, while the curves for temperature indicate the condition in the reaction tube, the curves for gases express the rates at which these passed through the meter at the outlet of the apparatus. In experiments at high pressure the gases took an appreciable time to pass from the reaction tube to the meter, *e.g.*, approx. 3 mins. at 50 atmospheres, and this explains the delay in methane collection shown by Figure 5.

We are not quite certain of the explanation of the apparent evolution of small quantities of hydrogen shown in Figure 5 below 600° C. There have been similar observations in other experiments but not in regular fashion. It appears unlikely that the hydrogen was produced by thermal decomposition of the coke. It might have been due to the liberation of adsorbed hydrogen but, probably, the observation is no more than an irregularity caused by deposits partially blocking the outlet of the reaction tube.

There is no doubt that Mr. Rhead's interesting suggestion to carbonize coal in a closed pressure retort would result in an increase in the yield of methane. Experiment is required to determine what proportion of the hydrogen in the coal can be obtained as hydrocarbons and such experiments are considered to be an important part of our future work.

Mr. Finlayson rightly emphasises that the production of gases containing over 80 per cent. of hydrogen is a well-established technical process. In experimenting with mixtures of hydrogen and carbon monoxide we used weaker mixtures but, it will be appreciated, mainly to exaggerate the effects we wished to observe. The indications of the experiments are that the presence of carbon monoxide in the gas used for hydrogenation will impair the results obtained but not to a serious extent with the small percentages of carbon monoxide likely to occur.

Mr. Finlayson then discusses the alternative arrangements of introducing pressure into a complete gasification process. Whether or not it is cheaper to use oxygen or converted water gas obtained by normal methods may depend upon circumstances. It may not be generally realized, however, that with the oxygen method, the volume of air requiring compression for oxygen production will be less than the volume of converted water gas and, moreover, separation of the air does not require so high a pressure as those anticipated for the hydrogenation reactions. When using oxygen, only the comparatively small volume of oxygen needs compressing up to the reaction pressure. When the whole process is considered, the convenience of high pressure in the handling and treatment of large quantities of gas makes it tempting to introduce the pressure at as early a stage as possible.

With reference to Mr. Finlayson's mention of "nascent" hydrogen, the present indications are that hydrogen produced *in situ* by decomposition of the coal or by reaction with steam is no more effective as an hydrogenating agent than molecular hydrogen from an external source. What appears of more account is the production of "nascent carbon" by the decomposition of the material being hydrogenated.

Mr. Hodsman's remarks on the growing importance of the type of tar likely to be produced in a scheme of "complete" gasification involving hydrogenation, leads on to the experimental work that is now beginning with a larger apparatus. This will permit the nature of the tar produced to be examined and the results should lead to a more definite opinion upon the value of a preliminary carbonization.

Dr. Townend refers to the data in the table given on page 15. It should be pointed out that the amounts of CH_4 obtained with the mixture are expressed as a percentage of the dry volumes of gas obtained and thus are identical with the corresponding figures given in column 4 of Table 1. So as to make them directly comparable, the amounts of CH_4 obtained with hydrogen are also expressed as percentages of the same dry volumes of gas obtained with the mixture.

7th Report of the Liquor Effluents and Ammonia Committee.—Communication No. 168.

Mr. P. PARRISH (South Metropolitan Gas Company) wrote: I am pleased to be afforded an opportunity of contributing to the discussion on the 7th Report of the Liquor Effluents and Ammonia Committee. I have devoted much time to this investigation and an attempt has been made to be of general service on both practical and theoretical aspects. The work of the last two years has covered many phases, as the Report clearly reveals. Time, unfortunately, does not admit of dealing with all these features consecutively to-day.

The origin of the investigation appears to be well-defined in my own observations on the 4th Report of the Liquor Effluents and Ammonia Committee.* The views that I then expressed were largely of a general character and certainly had not assumed any definite form, either as to the precise type of plant or the best method for the utilization of the concentrated gas liquor. My association with large Works, dealing with all kinds of heavy chemicals, alkali, ammonia, etc., covers a continuous period of 36 years, during which I have had a unique experience of the unit processes of chemical engineering, costing and accountancy in all its manifestations.

The first step taken was to enter into a contract with the Coventry Corporation Gas Department for the supply by them to the Works of my Company, Phœnix Wharf, East Greenwich, S.E. 10, of concentrated gas liquor. The next step was to design a plant that would incorporate (*a*) automatic working, (*b*) partial decarbonation of the gas liquor, with the use of a minimum quantity of extraneous steam, (*c*) utilization of practically all the heat of exchange, and (*d*) the production of concentrated gas liquor containing about 20 per cent. of ammonia by weight, with a total consumption of steam of 25 per cent. The specific gravity had to exceed 1·0, and it was desirable that

* *Vide* Trans. Inst. Gas Eng., 1934-35, **84**, 234 and 236.

practically the whole of the H_2S should be retained in the concentrated gas liquor.

Shortly afterwards, the Coventry Corporation Gas Department placed an order for a Thorncliffe-Baldurie type of plant, which had become very popular during the previous three years. The Coventry Corporation Gas Department specified that their existing sulphate still should be utilized, and that some old boilers which were on the site should be used for storage of the concentrated gas liquor. Hybrid plants are not to be desired; it is far better to have a complete plant, all the elements of which have been designed for the special requirements. This, however, was impossible in the case of Coventry, as the Chief Engineer wished to meet his Committee's desire that a minimum of expenditure should be incurred.

Erection of the new form of plant was commenced in October, 1935, was put into operation on 8th January, 1936, and the first tank was loaded on the 11th of that month with 11·72 tons of concentrated gas liquor containing 22 per cent. of ammonia by weight. The plant has continued to operate since, despite the fact that certain minor modifications have been made, largely because the ammonia concentration of the gas liquor and the temperature of the cooling water were modified, and there were certain imperfections of the original still. In any case, the following list is peculiarly imposing, revealing, as it does, that there has been continuity of operation during the whole of the period, and that the Chief Engineer, Mr. Langford, has never had any misgiving about the plant functioning in a satisfactory way.

Details of Concentrated Gas Liquor Supplied by Coventry Corporation Gas Department.

Month.	Weight, Tons.	Average Percentage Ammonia by Weight.
1	2	3
1936.		
January	67·03	18·58
February	158·76	18·62
March	151·26	19·85
April	124·81	19·62
May	138·03	19·30
June	141·20	18·44
July	131·71	18·43
August	107·93	17·76
September	93·31	19·55
October	108·55	19·72
November	119·95	19·19
December	92·80	20·00
	1,435·34	
1937.		
January	134·01	19·48
February	133·01	19·79
March	124·07	20·41
April	179·56	18·69
May	120·62	18·51
June	140·03	19·02
July	176·90	18·88
August	8·65	17·93
September	92·10	19·51

Tabulated Figures of Performance.

(*a*) Average throughput of plant .. .. 19,440 gal. per day of crude liquor, containing 1·862 per cent. of free ammonia.

(*b*) Steam consumption .. .. 25·3 per cent. on weight of crude liquor distilled.

(*c*) Average production of concentrated gas liquor 22·1 per cent. by volume = say 19·50 per cent. by weight.

(*d*) Ammonia content of effluent liquor .. 0·039 per cent.*

(*e*) Overall efficiency .. .. 98 per cent.

* High due to the elements of the still often tilting and becoming unsealed.

Consideration of the above figures leads one to congratulate Mr. P. N. Langford, the Chief Engineer of the Coventry Corporation Gas Department, on the practical interest and keen supervision which he has exercised in the operation of the plant, and on his readiness to accept suggestions embodying better means of control, etc. Equally, one cannot fail to offer congratulations to Major Kitching, the General Manager, and Mr. Gerald W. Allott, General Sales Manager, of Newton, Chambers and Company, Limited, Sheffield, on the skill of their staff in the erection of the chemical engineering equipment, and on the facility with which they have executed minor modifications of control. Dr. Key speaks in unqualified praise of the controls, and on the fact that they work within 0·5 to 1·0° C. of accuracy.

It is a pity that the Research Chemists have been withdrawn from this plant. Expressions of concern have been voiced from several quarters. Ideas that Dr. Key and I had frequently discussed, as regards the manufacture of liquor ammonia, were already beginning to take shape, and to fulfil our most sanguine anticipations. We had long held the view that the methods of manufacturing liquor ammonia, 25 per cent. suitable as a product for oxidation to nitric acid, and a variety of other purposes, were more or less wrong in principle, and expensive withal, in the matter of the cost of steam. After many discussions it was agreed that in the manufacture of liquor ammonia a reversal of certain current technique should be followed. Such modifications indirectly would have resulted in a better realization for gas liquor, to the extent of several thousands of pounds.

The findings of the Report confirm in many details the fundamental principles enunciated in patent specification No. 449,347, which was the basis of the Coventry concentrated gas liquor plant, and its operation. Despite what Dr. Key has remarked, and what Professor Cobb has wisely emphasized, all of which observations are perfectly true, it is preferable to manufacture concentrated gas liquor, rather than to produce concentrated ammonia liquor. Where the product is inclined to swing in the direction of concentrated ammonia liquor, there is likely to be loss in the transportation and discharge of this product, by reason of its greater ammonia volatility; moreover, in certain cases, the specific gravity will fall below 1·0, and class 6 railway rate will apply (as contrasted with class 3 for concentrated gas liquor having a specific gravity above 1·0), while at the same time the quantity of sulphur as H_2S which is carried, per unit weight of the ammonia product, will diminish considerably. With proper arrangements at the central chemical works, concentrated gas liquor can be delivered in a satisfactory condition for nine months of the year without occasioning trouble. For the other three months, special facilities can be provided, which ensure discharge under conditions where the loss is negligible. Further, concentrated gas liquor can be produced at the lowest cost per unit of ammonia, and its transport can be effected at a minimum cost, having regard to the sulphur that can be conveyed.

A Most Valuable Document.

On the subject of the Report as a whole it can be said without exaggeration that it is a most valuable document—probably more valuable than any which has hitherto been issued by The Institution of Gas Engineers. The wide and reliable data on one of the best forms of concentrated gas liquor plants, coupled with the comprehensive information on other aspects affecting problems associated with the concentration of gas liquors, must render it a document in great demand in all European countries, the United States of America, the Colonies and dependencies. It will be in daily use for years; some of the aspects with which it deals will be the subject of research by other technical institutions and universities, and one will wonder at the number of cross-checks and related data that have been undertaken by Dr. Key and his colleagues in order to ensure accuracy. The Institution should be proud of Mr. Botley (Chairman of the Liquor Effluents and Ammonia Committee), Professor Cobb and Dr. Key, and the other members of the Liquor Effluents and Ammonia Committee, for the compilation of such a report, which is of an unparalleled character.

And what of Dr. Key? We can say, *multum in parvo*, he is an agreeable young man, with a flair for research, a keen knowledge of the technique of gas manufacture and the treatment of its allied products; he knows how to read, where to obtain information on work that has already been undertaken; he is peculiarly quick in this connexion. He is transferred from the Liquor Effluents and Ammonia Committee—not at the desire of that Committee— but he carries with him the best wishes of all the members, who are confident that he will make a definite mark for himself, whether the investigation be the fundamentals of the methanization of water gas or whether it be the practically complete elimination of sulphur compounds from coal gas.

Mr. W. F. Thorne (Bournemouth) wrote: It would appear, as Dr. Key suggests, that the lack of correlation between his graphs and our own is probably due to our not having been aware of the carbonate $\rightleftarrows$ carbamate equilibrium. Nevertheless, the results experienced on the large-scale plant gave reasonable confirmation of our graphs. This again is probably due to the fact that both the concentrated liquor, as made, and the test specimens, used to construct the curves, had not reached equilibrium.

With regard to the effect of ammonium sulphide on the crystallization of concentrated liquor, we have noticed many times during the working of the concentrated liquor plant that when there is a larger amount of H_2S in the crude liquor, less decarbonation was necessary in order to produce a concentrated liquor that did not crystallize.

It would appear, therefore, that the more ammonium sulphide is present the more ammonium bicarbonate can also be present without crystallization occurring.

Dr. A. Key, in reply, wrote: Mr. Napier and Mr. Banks made statements in the discussion which appear to be in direct contradiction to each other. Mr. Napier said that

he was pleased to see emphasis laid on the necessity for cooling the liquor after decarbonation, as this was most important. Mr. Banks said that the suggestion that a low still head (meaning liquor inlet still) temperature favours stripping of the liquor is not generally applicable. The reason for this divergence of view would have become apparent had Mr. Banks been able to describe the type of plant from which he was quoting results. In plant designed to produce liquor containing more than 20 per cent. ammonia by weight it is necessary that there should be some refluxing of the gases from the still. In the Thorncliffe-Baldurie plant described in the Report and referred to by Mr. Napier this refluxing takes place in the upper part of the still itself and can only be accomplished if the liquor entering is sufficiently cool for the purpose. Mr. Banks, as he told me later, was referring to a Wilton plant in which the necessary refluxing is effected by two reflux condensers situated before the main condenser and cooled by liquor and water respectively. It is not therefore necessary in this particular case that cool liquor should enter the still. The merits of the two systems cannot be discussed here; they are probably equally good means to the same end.

The plant described by Mr. Banks uses a considerable amount more steam than that described in the Report. Mr. Banks' explanation for this is difficult to understand, since steam consumption cannot appreciably be affected by the efficiency of ammonia absorption in the condensers. Unless the steam is very wet (as it may be, being exhaust steam), it would appear on the face of things that the amount used is greater than necessary to secure efficient decarbonation and a good effluent. In the Coventry plant the use of such an excess of steam is impossible without weakening the product, but in the Wilton plant it can be removed from the still gases in the reflux condensers.

The written contributions from Mr. P. Parrish and Mr. W. F. Thorne do not contain criticisms of the Report and therefore call for no reply here.

1st Report of the Pipes Committee.– Communication No. 170.

Mr. J. A. GOULD (South Suburban Gas Company) wrote: I would congratulate the Chairman and members of the Pipes Committee on the most useful work which they are doing.

I feel that the description "Pipes Committee" is rather misleading, and I would suggest that if the Committee is to advise us upon the many distribution methods and problems referred to at the end of the introduction to its Report, the title should be "Distribution Committee." The technical problems (other than lighting) relating to Air Raid Precautions, at present under consideration by the Gas Works Safety Rules Committee, to which reference is made in the 3rd Report of the Research Executive Committee, might with advantage be dealt with by the "Distribution Committee" in so far as the precautions on the district are concerned. Air Raid Precautions as they affect our district activities involve special problems and close co-operation with local authorities, particularly in regard to damaged, contaminated, and obstructed highways resulting in injury to mains and other gas distributing plant.

The notes on methods of dealing with gas escapes which affect Post Office Telephone plant are most instructive and useful. As one who has had a strict training in the work of escape detecting for many years in the Metropolis, I can appreciate fully the necessity for the precautions stated. The carbon monoxide detector devised by the Post Office Engineers is in general use on my Company's district, and is found to be of considerable assistance in escape work.

I am of opinion that the statement on page 6 of the Report needs to be amplified, since although the duct system and its jointing boxes may have been ventilated I have found by experience that the box in which gas is still present may not be the nearest to the source of the escape. The statement of the Committee would not necessarily apply to leakages occurring on plant on a gradient.

With regard to the inspection of clayed-up ducts, it is often necessary to leave the ducts sealed for several hours —sometimes all night—particularly when searching for small escapes. As we all know, the work of tracing and stopping leakages has often to be carried out at night, making it necessary for some form of artificial light to be used. The danger of a naked light is very much appreciated, but the possibilities of switching on and off an electric lamp in a joint box containing coal gas are not so well known. The switching on and off of inspection lamps should be done well away from a gas-affected box, and in no circumstances in it.

The use of a blower for the quick ventilation of ducts and boxes is much to be recommended.

With regard to Wrought Iron Specifications, particularly Publication No. 12, it would be of interest to hear the result of the Committee's review. I have given careful study to the question of wrought iron tubing, and have come to the conclusion that Publication No. 12 could be amplified usefully. In this connexion I found the draft British Standard Specification No. 32 for Wrought Iron and Steel Pipes (screwed and socketed) for Gas, Water, and Steam very helpful and instructive, although to me it appears desirable that it should be given some further consideration with regard to the drifting of tubes and to other small, though none the less important, points.

Before concluding, I would like to refer again to the last paragraph of the introduction to the Committee's Report. There are numerous matters which might well be dealt with by a Distribution Committee to the great benefit of the district people. I have in mind the contentious question of supporting gas mains where undermined by other undertakings, and the standardization and agreement with other undertakings as to the positions of public utility services in highways. The growing practice of sewer and road contractors to use mechanical excavators needs careful consideration, since I have found that such use often results in damage to gas service pipes and mains. The standardizing of depths of pipes might do much to lessen the trouble.

In conclusion, I would take this opportunity to express my thanks to the Chairman and members of the Committee for their very useful work, and would add the hope that the scope of their investigations may be enlarged to the general advantage of the Gas Industry.

Mr. H. J. ESCREET, in reply, wrote: I am much obliged to Mr. Gould for his contribution to the Discussion. I am inclined to agree that as the Committee is "to deal with all matters relating to pipes and problems arising therefrom" it might be of advantage to alter the title to that of "Distribution Committee." No doubt the Council of the Institution will give this matter consideration.

I see that Mr. Gould considers that the notes on "Methods of Dealing with Escapes of Gas into Cable Ducts and Boxes" require amplification. While I agree that the location of escapes of gas into duct lines is a complicated problem—each case requiring individual treatment—I think that the statement to which Mr. Gould refers is generally true; it is, I am afraid, impossible to deal accurately with every set of circumstances in a brief article suitable for inclusion in the Report.

I am glad that Mr. Gould has drawn attention to the use of electric lamps and the importance of using these with care.

As I stated when presenting the Report, the Committee proposes to bring the specification for Wrought Iron Tubes into line with the new British Standard Specification.

Purging Gasholders by Means of Inert Gas, by F. M. Birks, O.B.E.—Communication No. 172.

Mr. L. SILVER (Gas Light and Coke Company) wrote: Mr. Birks has asked me to amplify his remarks on the limits of inflammability of gases and the effect on these limits of the inert constituents of the purging gas.

It is well known that there is for each combustible gas a range of mixtures with air over which the mixture is inflammable; that is, flame or explosion will be propagated through the mass from any point of ignition. If the proportion of combustible gas to air in the mixture is varied there is a lower limit below which the gas is too dilute to inflame, and an upper limit where the proportion of air is insufficient to render the mixture inflammable. These upper and lower limits of inflammability are different for different combustible gases and are characteristic of the gas. Thus for hydrogen the lower limiting mixture contains 4·1 per cent. of hydrogen and the upper 74 per cent., while for carbon monoxide the limits are 12·5 per cent. and 74 per cent. respectively, and for methane the range of

inflammability is much shorter—from 5·3 per cent. to 13·9 per cent. only.

For mixtures of combustibles it is possible to calculate the limits of inflammability with air from the limits for the individual gases. The method of calculation need not be gone into here. It is quite simple, however, and is based on a rule due to Le Chatelier, the significance of which is that, if mixtures of different combustibles and air, each mixture being at its lower limit of inflammability, are mixed with one another in any proportions the resulting mixtures are themselves at their lower limit; similarly with regard to upper limit mixtures. Thus a complex mixture with air that is at either the lower or upper limit of inflammability may be dissected, by sharing the air content among the several combustible constituents, into a series of simple mixtures, each of which is itself at its corresponding inflammability limit.

The effect of the addition of inert gases, such as nitrogen or carbon dioxide, to a combustible gas is to reduce the range of inflammability; that is, to bring the upper limit and lower limit closer to one another, until finally, by continued addition of inert gas the upper and lower limits for the mixture coincide and the mixture is no longer inflammable in any proportions with air. Thus the addition of eight times its own volume of nitrogen to hydrogen brings the lower and upper limits of inflammability with air to 37 per cent. and 76 per cent. of the mixture respectively, whilst the addition of sixteen volumes of nitrogen brings the limits to 73 per cent. and 75 per cent., so that in this latter case the mixture is inflammable only when mixed with not more than 27 per cent. nor less than 25 per cent. of air; another 0·5 per cent. of nitrogen renders the mixture completely non-inflammable in air. The effect of CO_2 in reducing the inflammability is about 60 per cent. greater than that of nitrogen; thus the addition of 10·2 volumes of carbon dioxide is sufficient to render hydrogen non-inflammable. This ratio varies slightly for different combustibles.

The proportions of purging gas, consisting, say, of 11 per cent. of carbon dioxide and 89 per cent. of nitrogen, in non-inflammable mixtures with individual combustible gases can be calculated by an extension of Le Chatelier's rule, and the rule can then be applied with slightly reduced accuracy to obtain the composition of such complex completely non-inflammable mixtures as those of coal gas or district gas with purging gas from the machine.

In the analytical control of purging the determination of the carbon dioxide is most convenient as it is simpler, more accurate and more rapid than the estimation of any one of the combustible constituents. Some slight solution of carbon dioxide in the water may occur, but the effect of this is that purging is continued to a somewhat higher margin of safety. This will probably be sufficient to deal with any evaporation of liquid hydrocarbon condensates into the gas mixture.

Gratitude to America.

Mr. E. B. Tomlinson (Birmingham) wrote: When one looks back over a lifetime in the Gas Industry, and remembers (1) the extremely anxious days spent in clearing gasholders and other gas apparatus before entering them for either examination or repairs, or (2) bringing plants into commission by recharging them with gas, and (3) the congestion of plants, buildings and railway lines, and in some cases the close proximity of dwelling houses, one feels very grateful to our American friends for introducing the safe method of purging by inert gas.

The American Gas Association published in 1933 a pamphlet on the purging of gasholders, which procedure they recommended. When Mr. A. W. Smith, the General Manager and Secretary of the Birmingham Gas Department, visited America some 3 years ago, he sent me detailed information of the Harrison inert gas purging apparatus as used by Mr. Humphries at Montreal. The Birmingham Gas Department some 2½ years ago constructed an inert gas purging machine which was used for clearing a gasholder at their Nechells Works. They have also recently made another large machine in 3 sections so as to be portable and have used it for purging a gasholder at the Washwood Heath station, both operations being carried out with entire success.

The Gas Industry is indebted to Mr. Birks for the Paper presented, which amply deals with all the fundamentals of the plant and is self-explanatory.

It may be that owing to the extreme rarity of untoward incidents in the clearing of gasholders or putting them into commission, there may be some engineers who do not ordinarily think the introduction of an inert gas purging machine a necessity, but I am sure that after due consideration of the safe method now available, no one would ignore such a means of carrying out a task which was always accompanied by considerable risk. At no time with this plant properly used can an explosive mixture be formed inside the gasholder.

Purging a Small Holder.

Mr. D. Cleave Cross (Lea Bridge) wrote: I have read with keen interest Mr. Birks' description of the plant he has used so successfully for producing inert gas for purging gasholders, and I saw it in operation when the Institution visited the Fulham Works of the Gas Light and Coke Company last June.

The principle, as explained by Mr. Birks, of producing an almost perfect inert gas by the complete combustion of coal gas, is one, we will agree, which is an ideal and safe method of purging the residual gas out of the gasholder crowns, and afterwards of clearing out the inert gas by means of air. For large gasholders, especially, this plant appears to be ideal, as it produces large quantities of inert gases quickly. I consider it very desirable that the purging operation be completed in the one day, because if the operation is spread over two days complete mixing of the gases will take place, and a larger quantity of inert gas will be required to obtain the final analysis as given by Mr. Birks.

I was also very impressed by the low cost of the inert gases produced, but I submit that a plant of the size as described by Mr. Birks is only of practical use to large Gas Undertakings, or groups of Undertakings, and is of little use for the majority of the smaller Works in the country which only have the necessity of purging and opening a gasholder on rare occasions, and if it were practicable to transport this plant, or one of a smaller size, on loan to Works as they required it, I feel the provision of the necessary supply of water and gas might be an almost insurmountable difficulty or expense.

I had occasion this last spring to open up a small 3-lift gasholder 90 ft. in diameter which has buildings in very close proximity (within 12 ft.), and then considering the question of purging with inert gas for safety; we had no available supply anywhere near of flue gas or inert gas. We used a number of cylinders of compressed carbon dioxide, and inserted the CO_2 into the inlet main of the gasholder. In order to get the CO_2 into the holder as quickly as possible, we fixed up a battery of cylinders discharging into a common pipe, and to facilitate a fairly quick discharge we had to play a small steam jet on the valves and connexions from the cylinders, as a rapid discharge from the cylinders tends to snow up the connexions and stop the discharge. A sufficiently large vent pipe was fixed to the centre of the crown, and taken up to approximately 20 ft. above the ground level.

This method proved fairly satisfactory as we were using an inert gas considerably heavier than coal gas, which would tend to drive the lighter gas out of the top of the crown, although from tests taken during the operations I am afraid the CO_2 was mixing fairly evenly with the rest of the gas.

We added sufficient CO_2 to give a high percentage of inert gas in the gasholder crown and then we proceeded to purge the crown completely with air from a small neighbouring compressor used for supplying air for paint spraying booths, etc. The test of the gas inside the holder just prior to opening up gave 18·6 per cent. oxygen and 2·2 per cent. carbon dioxide, representing 93 per cent. air in the crown.

While I have given this as an example of purging the crown of a fairly small gasholder very close to buildings, the expense of the CO_2 gas was very high as compared with the cost of the inert gas made in Mr. Birks' plant, which he gives as only 8d. per 1,000 cu.ft. Our method proved effective, however, and rendered our operations quite safe.

Conclusions Rarely Disputed.

Mr. James Jamieson (Edinburgh) wrote: I have been intimately associated with Mr. Birks on the Gasholder Committee and have examined many of the reports he has prepared and submitted. It is rarely, if ever, that his conclusions have been disputed.

For that reason I, personally, would be prepared to accept this method of purging as the safest and most effective which has yet been devised. It is true the plant is cumbersome and probably expensive and on that account its general adoption will be slow. The question of cost is not such a serious matter to a large Undertaking and more particularly so when the plant can be utilized for purging processes other than gasholders. Apart from purifiers, however, no regular use could be found for the plant even in a fairly large Undertaking.

I, personally, have a dislike for carrying redundant plant or plant in part time employment. In the Gas Industry we already have to carry a good share of plant of this kind. Where it can be eliminated without risk it has always been my policy to do so.

The purging and gassing of gasholders is a very important matter. I do not admit it is dangerous when proper supervision is instituted. It is no more dangerous in gasholders than in other parts of the plant where the presence of accumulated gas is possible. We open up condensers,

washers and scrubbers, etc., and depend upon free circulation of air as the means of purging.

It is true that this latter work is being constantly in process whereas it is only at rare intervals a holder is put out of or into commission. I had an experience in the spring of this year, however, which I do not want repeated. Contractors had to make an extension to a foul main, the original part of the main being left open to atmosphere for more than three weeks. One would have expected any residual gas in that main to have diffused in that time. All valves and connexions were tight. The whole system beyond the valves was under vacuum so that the possibility of gas passing back through the condensers can be discounted. The new section of main had been in position for more than four weeks when an explosion occurred, the cause of which we have not been able to ascertain. I do not say that if the mains had been purged by a machine of the description given by Mr. Birks the mishap would have been avoided. One would have thought, and I still hold the opinion, that any gas in the main should have discharged itself on account of the mains being open. Again the main was considerably extended and it is doubtful if sufficient gas could have remained in the old section to make an explosive mixture. Nevertheless, the explosion occurred and demonstrates very clearly the necessity of having standby plant either fully charged or completely purged of gas, and that an examination should be made from time to time to see that this is so. If this procedure were adopted it would certainly widen the field of usefulness for a purging plant, particularly in the larger Undertakings.

During the past 20 years I have put out of action 23 holders, 11 of which were put back into use after repairs and alterations had been made. That is an average of one per annum, but it does not work out that way in practice. An interval of as much as seven years elapsed in which a gasholder purging machine would not have been in use if only used for that purpose. On that account I feel a system of hire is essential if the method explained by Mr. Birks is to be extensively adopted. Indeed I go further and would recommend that purging and gassing should be included in the specification and entrusted to the contractors who are to construct or carry out the repairs to the holder. If that proposal were adopted purging machines, I have no doubt, would be extensively and profitably used.

In our case all the holders were purged by the application of steam and in no case was any difficulty experienced. The manhole covers were partly removed just before the holder grounded and wet steam immediately introduced. It is true that this process may prove a nuisance due to the evaporation of oil from the water and in a built-up area might be open to criticism. Nevertheless, 10 of our holders were in that category. We had complaints, but not of a serious character. If the holder is to be entered by workmen without the removal of the water I consider the conditions would be better and more agreeable with a holder purged by steam than by inert gas supplied at atmospheric temperature. Anyone who has attempted it will appreciate the difficulty in satisfactorily skimming oil from the surface of the tank water.

A weakness in the purging by steam arises from the fact that the holder is grounded before purging begins. A critical period must therefore be present, the extent of which may be determined by the amount of steam introduced. With an inert gas purging machine the holder can be completely purged afloat and the critical period entirely eliminated. That appears to me to be the most important difference between the two methods. I should, however, like to ask Mr. Birks if he has any other objections to the purging by steam. I have never used, nor am I attracted by, purging with air under pressure, although it also has the advantage of being applied with the holder afloat.

When putting a holder into operation the removal of the air is necessary, in my opinion, more on account of its effect on the quality of gas than on the danger of its presence, particularly if sufficient gas is available to inflate the holder fully. We have never had any anxiety in the blowing off from a stand-pipe attached to the crown of the holder, the pipe being fitted with a fine wire mesh hood similar to the vents used in benzole tanks. On that account I feel that inert gas for this purpose has little advantage over the more commonly adopted procedure. However, I should like Mr. Birks to give his opinion on that view.

At first glance at the machine shown on Plate 1 one might think the presence of flame was a danger in the event of negligence, but on fuller consideration it would appear that the chance of an explosive mixture being formed is remote. It is therefore a suitable machine for the purpose, but procedure to some extent looks complicated and, in Works where holders are only put out of commission at wide intervals, it could not be used with the same confidence as it would be if in regular use, say, by contractors. Again, there is the important factor of ensuring that the purging gases at all times are inert, consisting only of carbon dioxide and nitrogen and that no air is admitted; otherwise an unforeseen danger undoubtedly arises. I should like Mr. Birks to say what the machine costs and also how much coal gas is used to purge the inert gas from a holder being put into commission.

In the case of a waterless gasholder, purging by steam would be disagreeable if not impracticable; purging by air I dislike and on that account I, personally, welcome this Paper.

The Author's Reply.

Mr. F. M. Birks, in reply, wrote: Firstly, I should like to thank Mr. Hardie for his remarks, which summarize the advantages to be derived from the use of the purging machine.

Many contributors to the discussion, notably Mr. Pearson, Mr. Stewart, and Mr. Jamieson, have described experiences which serve to emphasize the necessity of purging even small plant in a proper manner.

I am particularly grateful for the contribution made by the staff of the Birmingham Gas Undertaking. They have done a lot of work in connexion with purging, and the remarks made by Mr. Rhead on the points to be observed in designing a machine for this purpose are especially useful. Mr. Pearson and Mr. Rhead both note the high temperature of the inert gas leaving the machine. It is explained in the Paper that this was due to a high output of inert gas relative to the amount of cooling water available. It was also found that the temperature of the gas fell rapidly as soon as it entered the holder connexions. In one of the cases quoted the purging plant was actually stopped during the operation, but no difficulties such as feared by Mr. Pearson were encountered. Mr. Rhead raises the question of the absorption of carbon dioxide by the wash water; this has been investigated and found to be negligible, and, as Mr. Silver suggests, any error caused by it would be on the side of safety.

I feel that the Gas Industry owes a lot to Mr. Williams and his Company for the pioneer work that they have carried out in modifying and improving the design of the Harrison machine. The method of purging adopted by them is very similar in effect to that described in the Paper.

Mr. Henshaw and several other contributors raise the question of hiring the plant. This would appear to meet the difficulties of the smaller Works which would only be likely to require the use of the plant at long intervals.

I am indebted to Mr. Cross and Mr. Stewart for descriptions of the method of purging plant with carbon dioxide from cylinders. As Mr. Cross says, it is far too costly for any but the smallest holder, but it is handy and relatively cheap for small vessels and short lengths of main.

I do not think that the use of steam for purging holders, as suggested by Mr. Jamieson, is likely to be as satisfactory as inert gas. Steam, however, would certainly assist in the removal of light oils from the surface of the water, as would warm inert gas when heavily charged with water vapour. The use of a gauze on the standpipe at high temperature saturated with moisture would appear to be of doubtful value; it would be easily ruptured by a small explosion; also, if the mixture were ignited and allowed to burn on the surface of the gauze, it would soon become hot enough to allow the flame to pass into the holder with disastrous consequences.

I should like to thank Mr. Silver for his valuable contribution on the effect of inert gases on the inflammability of gas and air mixtures.

Retort House and Exhauster Governing on Gas-Works, by G. Dougill, M.Sc.—Communication No. 173.

Mr. H. J. Toogood (Hampton) wrote: The stroke of genius of the B.K. Governor is, of course, the manner in which the valve balances the bell, thereby superseding the usual balance-weights and considerably reducing the inertia of operation. However, this entails that the bell lifts from its seal, whilst the valve sinks into its seal; hence the one increases and the other decreases in effective weight, so that the balance ought to be doubly disturbed, yet according to the charts it is not.

The only reference in the Paper appears to be in the conditions laid down, page 21, item 4. "Buoyancy error must be small." This is an interesting point but without

additional data to that within the Paper it remains problematical and I would therefore ask the Author to clear up this apparent mystery.

Furthermore, none of the illustrations indicates how the governor is loaded, neither does the letterpress throw any light on the important retort house adjustment.

Presumably the bell and working parts are housed in a dust-proof container. As no moving parts are exposed, where are the adjustments made and how?

Mr. G. DOUGILL, in reply, wrote: Mr. Hunter's clear resumé of the events which led to the work on the Coke Oven Plant relay governors emphasizes some of the difficulties which may be met with in automatic governing. At the same time I should like to thank him for help and encouragement during the progress of the work.

I am in agreement with the remarks made by Mr. Parkinson, though I am rather surprised that he should think a governor with light moving parts might be more liable to "hunting." The three main reasons for "hunting" are:—momentum (and inertia); time lag, and friction. As it is impossible to reduce any of the three entirely to zero, all governors have a tendency to "hunt," though usually in a correct design this can be controlled.

As regards the tar tower, Mr. Rogers, of Beckton, also fitted miniature tar towers to three early B.K. governors in No. 5 retort house with considerable success. Later designs, however, do not require these.

Mr. Parkinson also mentions an additional source of power for a relay governor—namely, clean gas. This is being used commercially with considerable success. The difficulty lies in the change of pressure as the holders cup and uncup, which can be eliminated by further governing, but at the expense of some of the available pressure.

Mr. Davis has apparently had trouble with a very small governor on experimental settings. These are frequently very troublesome.

There appears to be one point of difference raised by Mr. Webb with reference to the inertia of the exhauster. On the coke ovens, where our earlier work was done, there was no doubt whatever that the exhauster was quite unable to accelerate sufficiently rapidly at charging. The unit charge was, however, large and the make was increased from 600,000 to 650,000 cu.ft. per hr. over a period of 15 to 20 sec. Even in the retort houses, however, the acceleration needed was fairly large. Possibly the larger gangs working at Beckton and the higher rate of charging the retorts may account for this. It would certainly be difficult, if not impossible, to work without separate retort house governors under our conditions.

With Mr. Webb's other remarks I am quite in agreement.

As stated by Mr. Rogers, he has had charge of most of the B.K. governors at Beckton, and I should like to take this opportunity of expressing my appreciation of his co-operation in their development.

Mr. Toogood raises some interesting points, which are very important in governor design. It is quite agreed that the balancing of the bell against the valve results in a substantial decrease in inertia, but the reduction in weight of the valve and bell is even more important.

As regards the "buoyancy effect," the facts do appear surprising. Taking, however, an actual governor such as we are using with a valve tube 18 in. in diameter and a bell 2 ft. 6 in. in diameter, the error due to buoyancy is only 0·006 in. w.g. for each 1 in. valve movement. The maximum valve opening to give an area equal to an 18 in. full bore pipe is only 4·5 in., and valve movements of above an inch are rare. The reasons for this are as follows: It is usually found that a governor works best with its valve at ⅓ to ½ full open, and it is customary to adjust the exhauster pull to a suitable value to achieve this end. At ⅓ open the valve would be 1·5 in. from its seating and an increase of 1 in. to 2·5 in. would increase its area (and consequently the flow) by 66 per cent.

One of the reasons for this extremely small "buoyancy error" is the fact that the valve is designed to pass gas around its whole periphery; thus only a small valve movement is necessary to effect a considerable adjustment of the flow. As the valve under working conditions is practically frictionless these small movements can be made accurately; and, since they are small, rapidly, again reducing inertia effects. Thus it can be readily seen that each improvement in design was found to have cumulative benefits.

As regards the loading of the governor several schemes are possible. On our own governors direct weight loading is used. Normally the governors are delivered to control to atmospheric pressure with no additional loading. The weights required, particularly where "dry" hydraulic mains are used, are therefore small, and provision is made for adding these either to the small cap seal at the top of the valve rod, or to the bell, according to whether suction or pressure is required. A large dustproof sheet metal lid is used to cover the bell chamber, and in the centre of this is a small lid for weight alterations. Both these lids are readily detachable. Alternatively governors are working where the bell chamber is fitted with a gas-tight lid, and the bell is pressure loaded from a distance.

Ignition of Gas by Cold Catalyst, by L. W. Andrew, B.A., B.Sc., A. B. Densham, M.A., and E. W. Voice.—Communication No. 174.

Dr. H. T. ANGUS (Birmingham) wrote: This exceedingly interesting Paper brings together a considerable body of hitherto scattered information, and at the same time adds a great deal of information obtained by original work and service experience.

It is difficult to see an explanation for the effect of wire diameter on temperature of ignition, particularly as there is no flattening of the curve at larger diameter. Any blanketing effect of products of combustion would be expected to operate in favour of thin wire.

It is questionable if the effect of moisture itself can be regarded as poisoning. Where actual condensate forms on the pellet, its effect is almost certainly that of a protective film, but it is doubtful if moisture ever collects over the pellet in the absence of sulphur. We have had catalysts exposed to the open air throughout the winter and operation in a suitable housing was only 4-5 sec. slower than normal on very foggy mornings. On the other hand, catalysts exposed to the sulphur poisoning test as laid down in Appendix 1 almost invariably collected a film of moisture which completely prevented them from operating until it had been allowed to evaporate, when the activity of the catalyst was usually found to be unimpaired. In our Laboratories it was not found possible to adhere to the test conditions, as it was the exception rather than the rule for catalysts to ignite immediately on removal from the chamber on account of this condensation over the pellet. It is satisfactory to observe that an improved form of test is being developed. It is unlikely that the incorporation of a drying agent either in the catalyst or housing would prove of any value whatever, as it would become saturated in a very few hours' exposure.

The re-activation of catalysts by heating is well attested. In our experience, the more a catalyst is used the less subject it is to poisoning—for example, a catalyst exposed to products of combustion will have a longer exposed life if it be repeatedly used for ignition, than if it be allowed to stand unused under the same conditions, and a catalyst which has been so exposed will resume its activity if brought to red heat, provided poisoning has not gone too far and the pellet has not turned a grey colour.

Some experiments carried out to find the effect of exposure to very minute percentages of gas, such as might occur through leakage past an imperfectly seated gas cock, revealed the rather disturbing fact that impurities in the air itself were frequently more potent in poisoning the catalyst than exposure to minute gas concentrations or to repeated ignitions where products of combustion were properly removed after ignition. Nevertheless, our experience has shown that the application of catalysts is most successful where the catalyst itself is not housed in the immediate vicinity of a gas cock.

One of the most interesting points of our experience has been the difficulty of obtaining a uniform air-gas mixture over a section of tube housing a catalyst, and this, together with the provision of an adequate supply of mixture and the removal of products of combustion after ignition, appears to be a major factor in the successful operation of catalytic ignition.

The Authors' Reply.

The AUTHORS, in reply, wrote: We would like to begin by thanking Dr. Coward for coming all the way from Sheffield, and for his kind comments. We hope to proceed further with the analysis of the ignition process.

The thickness of the layer of burnt-out gas surrounding the pellet cannot be measured exactly, since there is no sharp boundary. But experiment shows that with a normal pellet it is necessary for the wire to project further than

2 mm. in order that the gas may be ignited. For smaller pellets the layer becomes thinner.

It is probably only by chance that the maximum in Figure 2 for town gas and hydrogen both coincide. The same factors—dilution by products and preferential adsorption of hydrogen—operate in both cases, though the matter is complicated by the homogeneous reaction in the gas phase surrounding the pellet. It is not suggested that carbon monoxide and methane are not oxidized on the pellet, once the latter is glowing; that they are oxidized is shown by the production of carbon dioxide.

Dr. Hartley has criticized our interpretation of Figure 2, and quotes evidence from his own work and that of Bone and Wheeler with a variety of catalysts to show that oxygen and not hydrogen is preferentially adsorbed. We would suggest that most of this evidence is irrelevant, since recent work has shown that the exact conditions are so important that it is impossible to generalize from the behaviour of one catalyst to another, or even from one temperature or pressure range to another. The subject is discussed in reference (3) of our Paper, and the best modern work* suggests that it is hydrogen which is preferentially adsorbed at the relatively low temperature which exists at the beginning of the heating up process.

Dr. Hartley has remarked on the variation of catalytic activity with use, and the necessity for a steady temperature some time before reaction starts in order to obtain constant results. While agreeing with this we would point out that the initial activity after standing in air is what is most important for catalytic lighters. We agree that the platinum black is bound to absorb some moisture from the air, but experiments shows that the absorption can be limited by use of the proper base material. The suggestion that a higher mixture rate helps to carry away the water formed is very interesting.

It is probable that carbon monoxide and methane may help to promote ignition, once surface oxidation has started, but the evidence is that in the initial stages they only act as diluents.

The importance of the interior of the catalyst can perhaps be overstressed. Platinum is very different from silver, in which metal, of course, actual solution of oxygen occurs.

The explanation of Figure 4 is probably connected with the thickness of the layer of burnt-out gas. The wires had all been annealed at high temperature to remove strains. It is well known that it is harder to ignite gas with fine wires, and that a sufficiently thin platinum wire can be fused in an explosive mixture of methane and air without causing explosion.

With a properly constructed catalyst and housing the ignition delay is due to the pellet; though if there is poor contact between pellet and wire, or the mixture strength is wrong, the pellet may glow and not the wire.

Attempts have been made to increase the activity of the wire by depositing platinum black on it, but up to date the results have not been very successful.

Dr. Hartley's suggestion to change from a static to a circulating method of test is interesting. Preliminary measurements have shown, however, that both methods give the same result.

It is very satisfactory that Mr. Atkinson has had good experience of fires with catalytic lighters.

We have not tried any alloys other than those mentioned in the Paper, and it would certainly be of interest to extend the work. Most of our measurements have been made with thermocouple wires; no very marked difference has been noted between these and commercially pure wires, but the point has not been very thoroughly investigated.

Silica gel has been tried as a support for the pellets, but the results have not, so far, been very encouraging.

We are grateful to Mr. Myerscough for his remarks, and we thank Mr. Masterman and Mr. Le Fevre for discussing the practical aspect of cold catalytic ignition.

We thank Dr. Angus for his written contribution.

Moisture in air which is not quite saturated does not usually inhibit activity, but it undoubtedly slows it up, even in the absence of sulphur oxides. The use of a slow-acting drying agent might have a very beneficial effect, provided that it could be reactivated by the heat of ignition whenever the catalyst was used.

It is surprising that Dr. Angus finds poisoning and reactivation increase the resistance of the catalyst to poisoning. We have made no exact measurements, but our general impression has been that each time a catalyst is poisoned and heated it becomes less active and less resistant.

Leaky cocks undoubtedly decrease the activity of catalysts, but no trouble is experienced if the housing is placed near a sound cock.

* Hinshelwood and Donnelly, J. Chem. Soc., 1929, p. 1,727.

Removal of Sulphur Compounds from Gas. Papers by H. Hollings, M.Sc., W. K. Hutchison, B.A., and R. H. Griffith, D.Phil.—Communication No. 175.

Mr. W. K. Hutchison, in reply, wrote: Dr. E. W. Smith has referred to the use of refrigeration and has given some interesting figures for the cost of the plant involved. It hardly appears that there would be any appreciable saving in total cost compared with a plant designed to circulate a greater quantity of oil and as regards running costs the steam used by the refrigerating plant, or alternatively the steam equivalent of the power used, must be taken into account. While refrigeration might effect an overall reduction in steam when applied to the orthodox process, it will be found that when applied to the process used at Kensal Green where the steam used per gallon of oil circulated is already low, the saving due to reduced oil circulation will be more than offset by the extra steam required for the refrigerating plant. One possible application is the addition of a refrigerating plant to an existing sulphur removal plant in order to provide a simple method of increasing the effective capacity when increase in carbonizing plant demands.

In reply to Dr. Schindel, it is suggested that the difference shown in Table 9 between the composition of the sulphur compounds in vertical retort gas and the gas from horizontal retorts and ovens should be allowed for in making comparison between oil washing and active carbon plants. However, more information as to the adsorption of individual sulphur compounds in commercial plants is required.

Mr. Birks defends the full scale test, but he would probably agree that the decision as to whether such a test is immediately justified will depend very much on the extent of knowledge of the unit processes involved.

Mr. Claxton has noted that the new type of high sulphur benzole obtained from plants such as that at Kensal Green will differ in behaviour from benzoles recovered by orthodox processes from gas of high sulphur content, where the proportion of thiophen sulphur is relatively high. Experience gained in due course with the refining of the newer type of benzole will undoubtedly be of great interest.

The improvements which can be effected in the normal technique of benzole recovery are referred to by Mr. Cooper. The steam consumption can, of course, be reduced materially, but the suggestion that the difference between the steam used in such a process and the steam required by the vacuum distillation process can be made up by surplus exhaust must depend very much on the circumstances at each Works.

Dr. R. H. Griffith, in reply, wrote: Mr. Evans' suggestion concerning promoted catalysts calls attention to the possibility that one might be able to select conditions such that the oxidation reaction was accelerated, but that the hydrogenation reaction, which he himself has studied so closely, was not affected or was even retarded. Laboratory experiments in this direction are already being carried out.

With respect to Dr. Macfarlane's questions, the method of preparation of the catalyst is important in order to secure long life of the material; the use of unsuitable supports leads to deterioration of the catalyst whatever the carrier may be, as the actual surface then becomes covered by a gummy deposit. The chief reactions going on in contact with the catalyst are the combination of oxygen and hydrogen, the oxidation of sulphur compounds and the reduction of nitric oxide; the first of these is responsible for the rise in temperature throughout the catalyst. The removal of sulphur by the process now described would not be sufficient if the gas were to be used for synthesis purposes, but our own experiences with alkaline iron oxide were similar to those mentioned by Dr. Macfarlane and were not very encouraging when coal gas with a fairly high sulphur content was treated. No strictly comparable data have yet been obtained with the Huff-Logan catalysts, but they are known to require appreciably higher working temperatures than those which we use, and they were also apparently developed for use with low sulphur water gas.

In reply to Dr. Schuftan, it has been found that nitric oxide is converted by the present process into approximately equal volumes of nitrogen and ammonia.

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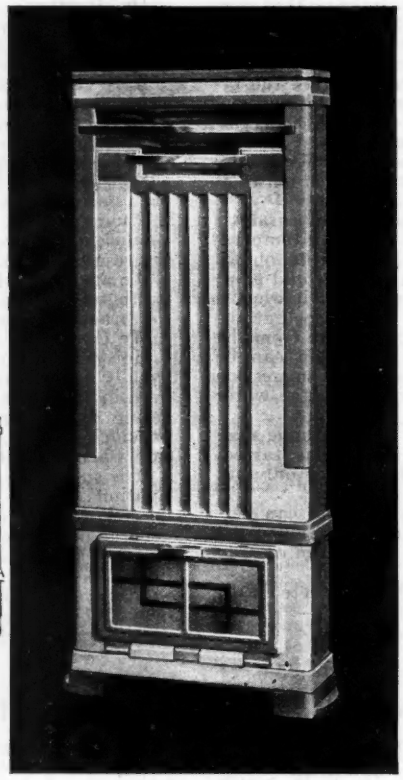

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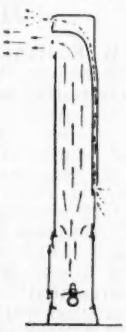

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French Gas Industry

Review of the 60th Congress of the Union Syndicale de l'Industrie Technique du Gaz en France

Continued from p. 459.

Application of Experimental Methods to the Selection of Coals

A. Alleaume described the experimental methods employed in connection with the selection of coals for carbonization by the Société d'Eclairage, Chauffage et Force Motrice.

For the assessment of the suitability of coals for the manufacture of coke, a box-test is employed. The box, which has, internally, a length of 20 in., a width of 9½ in., and a height of 15¾ in., is constructed of sheet iron reinforced with a U-iron cross on each of the two large sides, the two crosses being held together by means of four tie-rods. The box, with its charge of 79 lb. of air-dried coal at a packing density of 47 lb. per cu.ft., is submitted to carbonization in an inclined chamber oven, the carbonizing period being 24 hours. After discharge, the box and its contents are quenched and the coke is submitted to a shatter test. The appearance of the coke in the box affords an indication of the ease of discharge of the coke, a classification of 5, 4, 3, 2, 1 being employed to express degrees ranging from easy to difficult discharge. The percentage of material above 2 in. in size obtained in the shatter-test product is divided by 10 and the resulting figure, rounded off to the nearest half unit, constitutes a classification index for the coke. An average sample of the coke from the shatter test is submitted to proximate analysis. The remaining coke larger than 1 in. in size is broken by hand to a size of 1⅜ by 1 in., and its bulk density, apparent specific gravity, and friability are determined. The ash fusion point is also ascertained. Friability is determined on 11 lb. of the 1⅜ by 1 in. material in a horizontal trommel charged with 22 lb. of sea-shore pebbles (84 pebbles), the trommel having a diameter of 17½ in. and a length of 9½ in. The period of rotation is 30 min. at 35 revolutions per min. Friability is expressed as the percentage of fines passing a square aperture of 1/50 in. side present in the trommel product.

The carbonizing properties of coals are assessed in a modified Gray-King apparatus to a final temperature of 1,000° C., the cracking zone being maintained at a definite temperature, generally at 820° C. Curves correlating the calorific value and the therm yield of the gas at various cracking temperatures are given, as well as the assay results for a large number of coals and the results of numerous box tests. Among points investigated were the effect of the grading of the coal and the period of storage on coke quality. The behaviour of certain binary and ternary blends was also studied.

Experiences with Benzole Recovery by Means of Active Carbon

F. Delarozière and J. Duhamel gave an account of experience gained at the various works of the Société Lyonnaise des Eaux et de l'Eclairage and of laboratory work carried out at Nanterre in connection with benzole recovery by means of active carbon. Information was given as to the properties of the crude benzole contained in the gas from different types of carbonizing plant.

The properties of benzole recovered by use of active carbon depend on the extent to which the carbon is allowed to become loaded, a higher degree of saturation giving a product of a heavier character. In the operation of an active carbon plant it is, therefore, necessary to avoid overloading the carbon and to adopt a rational system of procedure as regards adsorption and stripping.

A series of tests with use of a pre-adsorber was carried out with a view to the production of crude benzole of improved quality as regards colour. It was found, however, that, due to its becoming loaded with resins, a pre-adsorber is responsible for such a heavy wastage of carbon that its use is uneconomical. When no pre-adsorber is used, the resins taken up by the carbon are removed at each cycle by the condensing vapours of the benzole, since stripping is effected in the opposite direction to that in which the gas been passed.

Various methods for the refining of crude benzole with a view to the attainment of colour stability were investigated. These included distillation at ordinary pressure and under diminished pressure, treatment with aluminium chloride (with and without activators), and with ferric chloride and treatment by means of a patented oxidizing process, details of which cannot yet be given. The use of aluminium chloride appears not to be sufficiently attractive, while treatment with ferric chloride, though giving an improvement in colour and gum content, is too costly.

With the oxidizing process, in which a very small quantity of a reagent is employed, a benzole containing 15 mgm. of existing gum and 392 mgm. of total gum per 100 c.c. generally gave a completely colourless product containing only 1 mgm. of existing gum and 10 mgm. of total gum, the maximum loss not exceeding 6·5%. At the same time, a greater increase occurred in the content of aromatic hydrocarbons in the product than could be explained by the reduction in the content of unsaturated hydrocarbons.

The remainder of the Paper dealt with the financial aspects of the use of active carbon, the point at issue being the increase in steam consumption associated with the progressive use of the carbon due to the necessity for shortening the adsorption period and thus for stripping at more frequent intervals. The royalties paid for the use of the carbon should be so graduated that due cognisance is taken of the increase in the working costs brought about by this factor.

(*To be continued.*)

Athletic and Social

Cambridge Bowls Club.

The annual bowls supper of the Cambridge University and Town Gas Light Company's Recreation Club, which took place on Nov. 13, proved a greater success than ever, as might have been expected after winning the Gilbert Cup for the second year in succession. The large attendance included Presidents of two local clubs. Replicas of the cup were presented to the winning team, and, in making the presentation, Mr. T. Scott praised the club for its keen play, and also expressed the opinion formed after twelve years' experience that the club was one of the best, socially, in Cambridgeshire.

Kilmarnock Social Club Gathering.

A social was recently held in the Recreation Club Room at Kilmarnock Corporation Gas-Works, when the workers and a members of the Social Club, who included all employees of ship of Dean of Guild Bryce, Convener of the Gas Committee.

The Chairman, in the course of his remarks, stated that the members of the Social Club, who included all employees of the Department, had invited fifteen of the retired employees to join them in a social evening. On behalf of the members, the Dean handed over a gift to each of the retired fellow workers.

Mr. R. Fife, Engineer and Manager, in toasting "Our Guests," expressed his pleasure that all the retired employees who had been invited to the function were able to be present.

Mr. Thomas Purdon, ex-cashier, responded to the toast and thanked the Chairman and Mr. Fife for their kind references to himself and his colleagues.

Newcastle Ex-Soldiers' Dinner.

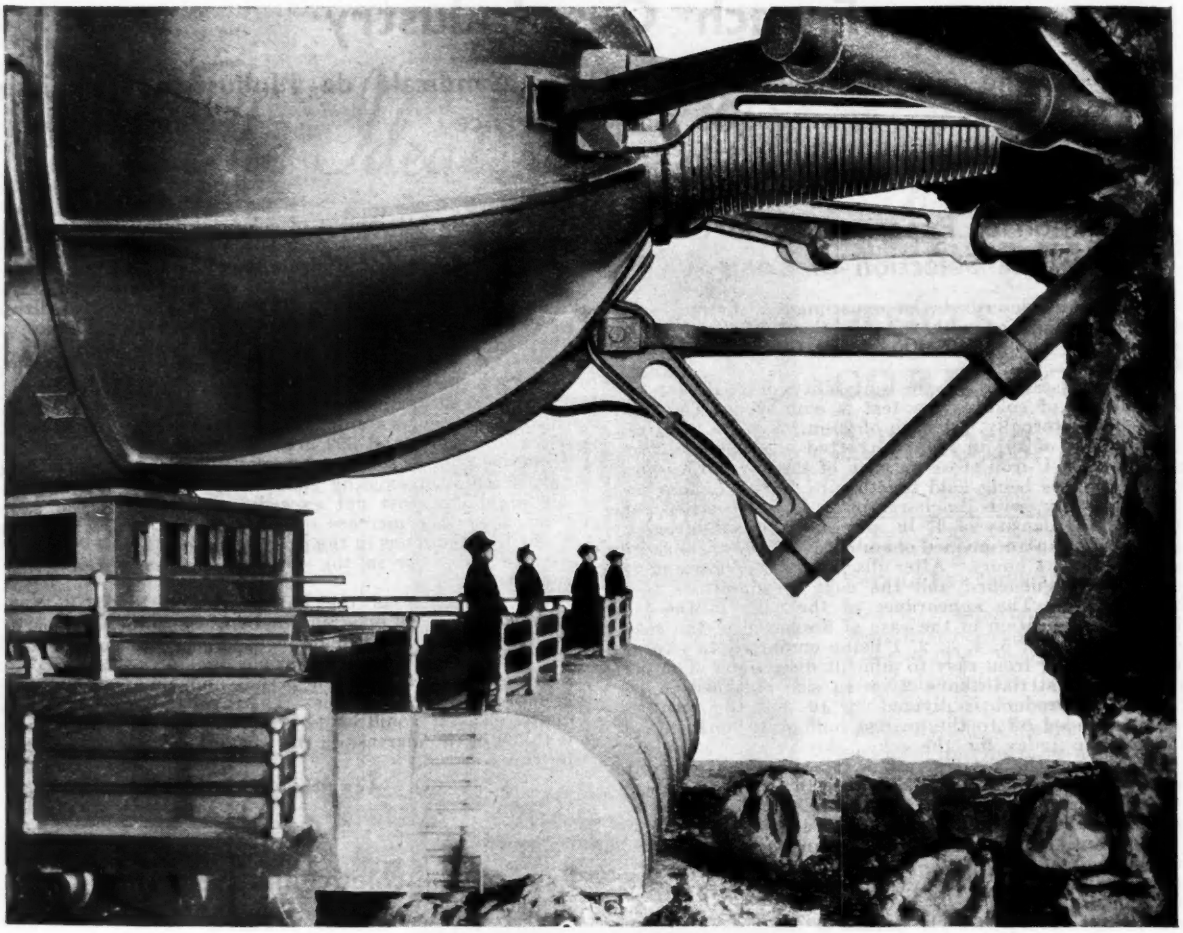
Members of Newcastle-upon-Tyne and Gateshead Gas Company Head Office Clerical Staff who served overseas in the great war held their 18th Annual Dinner in the Royal Turks Head Hotel, Newcastle, on Friday night last. Mr. Edgar Walton presided. An enjoyable programme was contributed by Messrs. Dewhirst, Henderson, Borthwick, Simpson, Lane, H. Goodfellow, and A. Taylor.

Perth Whist Drive, Supper, and Dance.

The third annual whist drive, supper, and dance of the Perth Corporation Gas Department was recently held in York House.

In the absence of Mr. A. C. Rea, Engineer and Manager, Mr. T. R. Sawers, Assistant Engineer, extended a welcome to the company of over one hundred, who afterwards played whist. After supper, there was dancing to music by the Savona Dance Orchestra, the M.C.'s being Messrs. L. Locke and W. Craig.

The whist winners received their prizes from Mrs. A. C. Rea, who, together with the donors of the prizes, was cordially thanked on the call of Mr. W. Craig.



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Developing the Heating Load

With Special Reference to Gas-Fired Central Heating Installations

By
Wm. A. BISHOP
Sales Superintendent of the Croydon Gas Company.

From a Paper presented to the Southern Association of Gas Engineers and Managers, at a General Meeting held at the Hotel Victoria, London, on Nov. 19—the PRESIDENT (Mr. S. E. Whitehead, of Southampton) presiding.

When I last had the privilege of speaking at one of this Association's meetings, I took as my subject "Facing Intensified Competition." In a way, my remarks to-day will be complementary, for I want to draw your attention to potential markets which our Industry has largely neglected, principally, as it seems to me, through lack of enterprise. In particular I propose to develop my previous suggestion that I feel we only need more flexibility in our gas pricing policy, as applied to large-scale space heating and water heating, to get a substantial share of this business. And this involves that controversial question—tariffs; particularly complex in the sphere we have now to consider, because for heating-plant purposes, we cannot altogether disregard the cheapness of coke and coal.

I had in mind as a title for this Paper: "Central Heating by Gas." I abandoned it in favour of the above title, as this seemed to be more fitting and to give more scope; for we are at present concerned with selling gas in bulk—in greater bulk—both for large space-heating and large-scale water heating purposes. We have also to be concerned, more than is usual at the present time, with promoting the use of gas for the more general heating of the "better-class" home. And here, too, we have immense opportunities.

In a footnote,* I quote some very pertinent remarks by a Canadian gas official, Mr. McGarvey. No doubt, conditions in the Canadian Gas Industry are very different from ours. But when Mr. McGarvey emphasizes the coal trade's activities in furthering competition out there with gas and oil on the basis of automatic operation, we seem bound to pay attention to what he says.

Just now, however, let us devote attention to the heating by gas of places of public assembly, such as churches, halls, schools, civic buildings; to shops and offices; to the heating of water for communal domestic purposes in blocks of flats; and to heating water for swimming pools and baths, and for communal washing baths. These are the "large-scale" loads to which I have referred, and in such cases I know, from my association with various members of the Institution of Heating and Ventilating Engineers, that this body is well aware of the merits of gas.

But I am told that, with a few noteworthy exceptions, there appears to be much inertia to be overcome within the Gas Industry itself. For one thing, there is such great diversity in gas prices. Our main problem now is really how to make our primary fuel available at economic prices for large heating loads, rather than one involving the technical principles of heating and ventilating engineering. The technique of this wide subject is well understood and practised by a competent body of experts. We have not to consider the design of plants very much. This is the heating engineer's job, and, generally speaking, it is not our business to tender against him or to compete with his technique. In most cases, given a reasonable price for gas, the heating and ventilating engineer will prefer gas. At any rate, I have always found this to be so, and heating and ventilating engineers have encouraged me to discuss fuel prices and running costs. Oddly enough, it is much more with our own internal economics that we are concerned, for to some extent we are competing within ourselves. On the one hand, we have to sell gas (although we are selling far too little of it for heating purposes). On the other hand, we have to sell our coke!

Let us consider the steps to be taken to gain a firmer foothold on the central heating load. I am using the term "central heating" because, although to some extent it is a misnomer (and clearly it is where large space heating is so effectively and economically catered for by overhead radiant panel heaters), it conveys the idea of loads outside the scope of present-day domestic heating.

In the first place, it is largely a question of the price of the heat unit in gas as compared with the price of the heat unit in coke and other solid fuels, in oil, and, to a lesser extent, but nevertheless in growing degree, in electricity. Table 1 gives some figures in this connection. It is also a question of the *utilization* of fuel at economic and competitive prices; and I would again emphasize that if we are to develop to any material degree large-scale space heating and bulk water heating, we must remember that we are up against keen competition calling for more attention to an economic pricing programme for our gas. The price range must, in my view, show measurable variation for different classes of business outside the average "domestic-consumer" or "flat rate" class. Large-scale heating is a special subject, and so is power-production, catering, bread-baking, &c.

In other countries of the world the need for a wide range of prices has been felt, and in America, Canada, Australia, and Germany. the Gas Industry has turned its attention to big heating business and to attractive, but nevertheless *economic*, tariffs to get it. In this country we seem a little nervous of losing our coke market; but I don't think we have cause for much anxiety on this score. Coke, at the present time, has no selling problem—in fact, more coke is needed. Therefore, the greater the volume of gas consumed by heating plants, the greater the amount of coke available; and more gas will also be available for benzole extraction.

There are other reasons why it is greatly to the advantage of the Industry actively to push large heating loads. For example, gas-fired central heating plants are more or less permanent. They are not likely to be displaced at the whim of responsible authorities, in view of the capital cost involved. Central heating means a substantial load per consumer. It helps the "overheads" and has a tendency to increase the average consumption per customer.

In the *Gas World* of July 17, the development of central heating in Germany was referred to in relation to the employment of "Pharos" gas burners designed specially for use in coke boilers. and among the remarks which interested me are the following:

> "From the standpoint of the gas-works, the interesting question is the effect of the growth of gas heating installations on the load curve of the plants. Comparative load curves for summer and winter days show that only during a very few limited hours of the day is the actual load higher in winter through the installation of gas heating. These are between the hours of nine and ten in the morning, between noon and one o'clock, and between seven and nine in the evening.
>
> "The increase during these hours is, moreover, very

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* "From almost the very beginning of the Gas Industry down to the present time, the domestic consumer as a class has been, and we hope will remain, our most valuable customer. . . . He is the foundation of our business, and we don't want to lose him. More than that—we want all the business he can give us—cooking, water heating, refrigeration, incineration, and, finally the heating of his home."

"When, however, it comes to the question of central house heating—that branch of our industry which has such enormous potentialities—there is every possibility that we may have to deal with an equally powerful competitor in the very near future."

"It is only within the past few years that the coal interests have shown any signs of fight in connection with domestic heating. Here was our golden opportunity. We had wonderful arguments in favour of gas fuel. It was clean, safe, convenient, easily controlled—in fact, it had everything—that is, everything but a low price ticket, and even this obstacle was often brushed aside with the argument of ultimate economy."

"To-day the scene appears to be rapidly changing. The powerful coal interests have begun to realise that much of their former business has slipped away from them, and they are really waking up. Time and money are being spent on scientific and engineering problems in an effort to place the coal industries in a position to successfully compete with gas and fuel oil on the basis of automatic operation."

"But it is not so much the object of this paper to view with alarm the aggressiveness of our opposition as to try to stimulate some thought as to our own activities. If this powerful competitor is to gain the position of being able to use most of the sales arguments which we have heretofore considered as outstanding features of gas as a heating fuel—and in view of what has already been accomplished, this seems quite possible—it would appear to be imperative that we devise ways and means to deal with the problem in no small way."

slight, amounting to only about 12 per cent., whereas during the remaining hours of the day the most noticeable feature of the curve is that the winter one is more even than the summer one, consumption during the slack daytime hours being considerably filled in. This means that the whole of the distribution network is being used more efficiently."

Improving the Load Factor.

Improving the load factor is a matter well worth special consideration, and it would form the subject for a most valuable Paper to this Association. I mention this, in passing, in support of my belief that central heating, if properly developed, must help our "overheads." It gives high consumption at small maintenance costs.

From data collected during my investigation of the tariff question, I confidently believe that the majority of undertakings, which are operating well-equipped works, capable of far greater output than they now enjoy, and which have distribution systems capable of meeting largely-increased demands, can afford to supply gas (and to supply it at a *profit*) at a substantial discount off the flat rate to obtain annual loads to the extent of a million cubic feet and upwards.

Central heating installations in my Company's area show wide variations in the size of plant, nature of building heated, and the annual consumption. Given the right type of plants and intelligent handling, a high over-all efficiency of utilization can be obtained with gas, and when all factors are taken into account, according to the merits of each case, business can be done at 6¾d. per therm downwards.

Ignoring price, what advantages, it may be asked, has gas to offer a consumer for central heating?

1. It is flexible.
2. It is clean.
3. It is reliable.
4. It is convenient.
5. It is labour-saving.
6. It is subject to thermostatic control.
7. It is safe.
8. No storage is entailed.
9. Its performance is constant.
10. Space is saved and building costs reduced.
11. It requires little attention.
12. A wide variety of suitable and well-designed apparatus is available.
13. There are no complicated controls to operate.
14. Comfort is ensured, by preventing overheating, through the use of remote temperature control.

These are some of the salient points which should recommend our fuel to prospective customers. We have to sell a more highly-priced fuel against competing interests, and we have to sell up to a standard of perfect performance rather than down to a price. If we try to sell on price alone, we shall fail badly.

There are, of course, as we know, other indirect and political reasons why gas should be employed, but unfortunately these points do not weigh very heavily with customers. They are concerned with price and performance, and we, who have some disadvantage in the matter of price, must make this good by emphasizing the benefits of its performance.

Where are the Customers?

I have often been asked the question—"Where are we to find customers to use gas for central heating?" Our prospective customers are to be found among such as architects, heating engineers, public authorities, industrial concerns, churches, halls, shops, offices, and schools; and the "better-class" householder. I would particularly stress the importance of cultivating the latter class of customer, as I am certain we have hardly yet touched the fringe of business of this type. I am afraid we have been too faint-hearted in the past in our endeavours to capture this large load, with the inevitable result that coke appears to have obtained a strangle-hold on this particular kind of domestic heating. We all know the number of new houses which are erected with a hot water system and several radiators—but how many of these are gas-fired? Very few. Invariably, a coke boiler is installed, although this in itself is not a guarantee that our fuel will be employed for central heating and water heating—in fact, I have met a number of cases in which anthracite or fuels prepared by low temperature carbonization have been employed.

Those responsible for the installation of heating equipment are aware of the normal price of gas and competitive fuels, and know only too well that, as compared with, say, coke or oil, the extra advantages of gas do not warrant the disproportionate increase in its running costs. It is usual to offer a substantial discount off the current price of gas, such as 25 per cent. or 33⅓ per cent. in order to encourage the growth of this uniform winter load; but unless there are special circumstances, I am afraid that the number of gas-fired plants installed will be far below those of coke and oil. I know that it is almost impossible to arrive at relative costs, as these must necessarily imply equal service in the broadest sense of the word, and varying fuels naturally give varying service to a greater or less degree.

If, however, we consider Table 1, below, it will give us an approximate indication of the price at which we must supply gas in order to compete with other fuels on purely a cost basis.

TABLE 1.

(A) Fuel.	(B) Calorific Value.	(C) Price.	(D) Price per Potential Therm.	(E) Efficiency.	(F) Price per Useful Therm.
Coke ..	12,500 B.Th.U. per lb. ..	35/– per ton.	d. 1·5	Per Cent. 65	d. 2·3
Anthracite	14,900 B.Th.U. per lb. ..	60/– per ton.	2·1	65	3·2
Heavy oil	19,000 B.Th.U. per lb. ..	90/– per ton.	2·54	70	3·63
Electricity	3,420 B.Th.U. per unit ..	½d. per unit.	14·6	100	14·6

From these figures it will be seen that, assuming an efficiency of utilization for gas of 75 per cent., it is necessary to supply gas at approximately 1·725d. per therm to compete on price with coke; at 2·4d. per therm to compete on price with anthracite; at 2·72d. per therm to compete on price with oil; and at 10·95d. per therm to compete on price with electricity.

The figures given in column F, however, represent merely the cost of transmitting heat into the water, and they have to be corrected for the useful application of heat in a central heating system. If the systems are operating continuously and are identical, then the cost ratio for gas and oil will be approximately the same as the cost ratio for heating the water. In the case of solid fuel, however, owing to variations in charging giving rise to time lag, low thermal efficiency at low fire and excess heat at high fire, the cost ratio of gas and coke will be decreased. Mr. A. H. Barker, B.Sc., has shown* that, owing to intermittent use, labour and misuse, coke at 1·8d. per therm results in the same effective heat service as is derived from gas at 6d. per therm. Generally, however, I feel it is fairly safe to say that unless we can supply gas at from 5d. to 5½d. per therm, we cannot expect to develop the use of gas for large-scale heating to the extent to which its advantages warrant, as people are only prepared to spend a little extra for the advantages to be derived. Running costs will always remain the prime consideration, as the other theoretical factors which contribute towards a decreased cost ratio are not fully revealed in practice.

In the case of large new buildings, such as blocks of offices, etc., where the heating is required, often for intermittent purposes apart from the general heating of corridors, etc., it is possible sometimes, owing to the flexibility of gas and the intermittent factor, to obtain orders for central heating in competition with oil at 6d. per therm. This, of course, assumes that coke is not considered on account of storage and labour difficulties.

Pulverized fuel is growing for use in large plants; but I hear from two independent engineers who have had opportunities of gaining first-hand information, that this method of fuel utilization, while producing a very cheap therm, has attendant disadvantages and gives rise to heavy maintenance charges.

Coal† used by automatic stokers is mainly entertained for large plants only, and in this sphere competition from coal is much more severe than from coke, particularly when running costs are the primary consideration. But, fortunately, cost is not the only factor that has to be considered, and one of the purposes of this Paper is to emphasize that the great selling points of gas are *comfort*, *cleanliness* and *convenience*—items which cannot be assessed

* "Heating Buildings by Gas," by A. H. Barker, B.Sc., 70th Annual General Meeting, I.G.E., June, 1933.

† The utilization of coal by mechanical stokers was dealt with by Mr. Herbert J. Edmunds at a meeting in Derby on the 5th February, 1937, of the East Midland Branch of the Institution of Heating and Ventilating Engineers, and his remarks are reported in the Institution's Journal, Volume 5, No. 54, for August, 1937. There is not time to comment on the Paper at this meeting, but it warrants close and attentive reading.

Beyond alluding to Mr. McGarvey's remarks, I have not attempted to deal at length with competition from coal for large-scale heating, but I know of a number of plants using low-grade coal with automatic stokers, which, from the financial point of view, are giving satisfactory results. In one case, my Company was able to compete by offering a mixture of breeze and small coke at a low price.

in pounds, shillings, and pence, and which are increasingly appreciated as our standard of living improves. It seems, therefore, that the essence of good policy for large-scale heating is to assess the minimum rate at which gas would be profitable for loads of varying magnitude. Where gas is at a disadvantage in regard to running costs, the difference has to be translated into the value of comfort and convenience, needing good salesmanship and courage to resolve this argument into actual installations.

We want, more than anything else, to tackle the domestic central heating field, but it is useless attempting it under present conditions, with a separate meter and special discounts for specific uses of gas in the home. The attraction must be a tariff to embrace all the gas used. With competition eating in we must take a courageous step forward and open up other avenues of business—and here is one outstanding avenue to explore.

My Company has experimented with special two-part contracts for consumers who install gas for central heating and hot water supply and who will consume, say, 1,000 therms per annum. The standing charge should, if possible, be kept fairly low, and should, from the point of view of observing equality, be varied with the maximum hourly demand. At the Croydon flat price of 9·1d. per therm, a standing charge of £10 per annum (including meter rent) and a commodity charge of flat rate less 47½ per cent. discount, gives an all-in cost per therm, on a consumption of 1,000 therms per annum, of approximately 7d., reducing with an increased gas consumption. This tariff would include all the gas used; and while experience has shown that the cost of performing all the heating functions with gas is dearer than with solid fuel, certain people, in these days when the servant problem is acute, are willing to pay more for their fuel because of the excellent service they get.

Announcing the Special Tariff

Where consumers want to put in gas in place of coke for hot water, whether there are radiators or not, or where they want to make their houses "*all-gas*" (although this should not be a qualifying condition), I can see no possible objection to offering some such tariff as mentioned. One way of developing this business is to announce the special tariff in a brochure featuring the merits of gas for "central heating." The Gas Light and Coke Company have given us a bold lead in this direction, and I have before me their interesting brochure dealing with the subject. My Company, too, has in draft form a brochure somewhat on the same lines.

From the work we have undertaken here in analysing the uses of different fuels by a number of people in various walks of life and the amounts of their fuel bills, we have sufficient information to show that, completely to evict solid fuel in the home and to make houses "all-gas fuel" houses, gas must be supplied at a figure of just under 5½d. per therm. The evidence we were able to collect and the calculations we made, after paying due regard to efficiencies of utilization, revealed a figure of 5·118d. per therm. This cannot be done generally as yet, but I do suggest that we can take, and should gladly accept, two-part contracts on the basis of those outlined, where we *greatly* increase our load by evicting solid fuel in favour of gas.

What is the position to-day? Just how little gas caters for the total domestic heat requirements is shown by the fact that about twice the amount of coal carbonized by all Gas Works in this country is used for domestic purposes. Less than 20 per cent. of the total domestic heat requirements are met by gas.

In Mr. Masterman's last I.G.E. Paper he computes that the average present annual requirement of heat for domestic purposes per household amounts to 270 useful therms, of which gas and coke now supply nearly 40 per cent. in about equal proportions. "These two fuels," says Mr. Masterman, "can offer a combined smokeless fuel service normally at a cost no higher than raw coal, a condition fulfilled by gas alone with all its attendant advantages if its increased use and the adoption of special tariffs can reduce its price by about 30 per cent."

In the "GAS SALESMAN" for June, 1937, it was said that "the estimates given by Mr. Masterman show the consumption on the cooker to overshadow other uses for gas. Full development of gas for either space heating or water heating would, however, each double the cooking load, while other applications for gas can clearly be extended. The doubling of the present small water heating load would increase gas sales by about 5 per cent., while the provision of gas central heating to 1 per cent. of the gas consumers in the country would increase sales by about 10 per cent. As for space heating, we have recently strongly advocated the desirability of pushing the background heating load. The time is coming when there will be a much more general demand for heating which will 'take the chill' from a house, this heating being supplemented by localized radiant heating. Background heating could be economically carried out by burning a sulphur-free gas fluelessly."

It is true that gas is used generally throughout the year for cooking; but this is really our only all-the-year-round trade, apart from Monday's weekly "clothes washing" load. The refrigeration load—a more or less constant one—has yet to be achieved in anything like a general way. Our other trade is mainly seasonal. We get summer water heating and winter intermittent room heating. It has been suggested to me that I ought not to omit to mention the use of gas for household water heating by means of gas-fired circulating boilers used in circuit with coke-fired domestic hot water boilers. While there is undoubtedly an enormous field for the use of gas boilers for summer-time water heating, the load per individual installation is relatively small in the "average class" home, and does not call, generally speaking, for a special tariff. My Company has done a considerable amount of business with gas-fired circulating boilers mainly for *seasonal* use—the boilers being fixed to work in conjunction with existing solid fuel boilers; but in this Paper I wanted to consider particularly the all-the-year-round use of gas in connection with its much wider adoption in the home.

Solid fuel, chiefly coke, caters for the *bulk* of the hot water demand during seven months of the year, and its use is growing as hot water radiator systems increase in popularity. For psychological reasons we shall not generally displace the coal fire for a long time to come. What we can often displace is the coke boiler—either as a domestic hot water unit only, or as a combined hot water and heating unit where there are radiators and a calorifier for the hot water supply. This gives us an ideal load—another *constant* load—for hot water is required throughout the year.

We are not going to increase our sales of domestic gas very much unless we make up our minds on the following points:—

(1) Is it good business to substitute gas boilers for domestic coke boilers?

(2) Is it profitable, where we can treble present consumption, to offer a special contract which, for annual loads of, say, 1,000 therms (200,000 cubic feet) yields a price of about 7d. per therm?

(3) Have we any confidence in the growth of central or part-central heating in the home?

My considered answers are:—

(1) Yes, because the number of conversions will be limited, and coke is "booming." Also, in many cases, we are not ousting coke but low-grade anthracite fuels.

(2) Yes—very profitable.

(3) Yes—the field is enormous, but we are doing practically nothing to encourage it.

A prominent consulting heating engineer I met recently holds the view that coke is something which, despite cost, will give place to fuels which are more amenable to automatic control; and the fight looks like developing into a three-cornered one in the future, between gas, oil, and electricity—with the latter forging ahead. I believe that just as it is true to say that the future of gas is in heat, so it is true to prophesy that the consolidation of gas is to be found ultimately in complete gasification. No great strides will be made in the heating business until gas is available at from 5d. to 5½d. per therm.

I have found that not often are we asked to give the competitive costs for fuels which I have already referred to, but we are invariably asked to give an estimate of the annual cost of heating by gas. I would like here to add a word of warning about giving any guaranteed running costs without adequate qualification, as so much depends upon methods of use, periods of use, outside and internal temperatures, &c.

When gas-fired plant is installed, I cannot too strongly stress the importance of instructing carefully those responsible for the operating of the heating plant in its use—the operation of the thermostat, the times of lighting and extinguishing, and, where more than one boiler is installed, of the advisability of not having all boilers operating at low consumption during mild periods (such as late spring and early autumn), and as to the economies to be effected by having one boiler in use at or near its rated load. Moreover, it is very desirable indeed to watch the installation very carefully during its initial period of use, in order that any wastage or incorrect manipulation of the controls can be rectified before queries arise or mishandling the plant becomes a habit with the operator.

Central heating by gas, whether it be mainly in the

form of convection by the so-called "radiator" system employing heated circulating water, or by plenum air-conditioning and air-heating plant, has been criticized by technicians in the Industry as lacking "balance," meaning that the effect of feeling warm through a mild degree of radiation is absent. There is something in this, although, of course, there are various types of hot water systems available to-day, including the "Ray-rad" "radiator" and "radiant" panels, which give a certain amount of radiation as well as convection. Overhead low and high pressure gas radiant panels are coming rapidly to the fore, and I feel that in a number of cases these units will be expedient for supplementing general warming, mainly by convection from central heating boilers. The low-pressure, dull radiant panel serves an effective area of about 200 square feet and has a gas rate of 25 cubic feet per hour. These panels, which are switch-controlled, are suitable for large, lofty buildings such as canteens, factories, restaurants, public halls, etc., and there is little or no "time lag" as is experienced with central heating plants. Floor space is saved and comfort obtained at a temperature of 55° Fahr. as compared with an air temperature of 60° Fahr. when heating by convection is employed. There is a large installation of 90 of these heaters in a factory shop on our district, and the workers are comfortable in cold weather and satisfied.

On the question of comfort in warming such buildings as blocks of offices, flats, churches, libraries, etc., it must be remembered that, if an undue amount of convected heat is employed, there may be a tendency to lower the humidity of the air, with consequent irritation to the eyes, ears, nose, and throat of the occupants, so that, although an adequate temperature may be obtained, the object of the installation is defeated by the introduction of discomfort instead of the "comfort conditions" which have received so much attention during the last year or two.

One of the most comfortable buildings I know of is the new Wallington Public Library, which is heated entirely by panels, served by circulating hot water, in the ceiling. The flow temperature of the water is 90° Fahr. and the return temperature 70° Fahr. It is a low-temperature job with adequate heating surface. The atmosphere is comfortably warm. Ventilation is normal; there is no mechanical ventilating plant. The circulation of the water is effected by means of a small electric accelerator. A number of panels are used to heat the Wallington Town Hall, and here again conditions are very comfortable.

I know of a private house in which all the "background" heating is undertaken by low-pressure hot water "radiators" working in conjunction with an air-temperature thermostat in the hall, which keeps the air in the rooms at about 55° Fahr. to 58° Fahr. In the reception room, dining room, lounge, music room and bedrooms, gas fires are fitted. This is an ideal combination of convection and radiation, and it is most comfortable. I fully realize that in the home, central heating plants must, for comfort and psychological considerations, be regarded as "background" heating only, to be supplemented by gas fires or other forms of radiant heat. It is in this class of home—the well-to-do home—where much more business can be obtained if we set out to sell the "comfort" of gas heating.

We are often faced with the difficulty of existing plants—usually coke-fired, but sometimes oil-fired. Here, the main difficulty in wresting business away from solid fuel and oil is that of persuading the customer to dispense with a perfectly good boiler. The boiler may have cost £80; and before we can sell him gaseous fuel we have to induce him to spend, say, a further £80 on the installation of a gas-fired boiler. The argument is that the boiler has therefore cost £160, and that if he wants to revert to solid fuel in the event of his being dissatisfied with gas, he cannot do so. This, of course, is a hard obstacle to overcome, even when estimated running costs are not disputed. Therefore, the question of converting solid fuel sectional boilers to gas-firing is receiving very careful consideration in order to reduce capital expenditure. It has been ascertained that in Derby the Gas Undertaking has made progress in this direction, having some fifty such conversions in use, many of them in large premises, with a "fivepenny" gas tariff. (The ordinary price of gas in Derby is 7·5d. per therm.) Efficiencies of well over 75 per cent. have been obtained with these conversions, and in some cases the efficiency of the converted boiler is said to be higher than that of a boiler designed to burn gas!

When we come to domestic conversions, the main point which strikes me is that in many houses the common boiler serves radiators and supplies hot water through a calorifier. We know that this is a somewhat wasteful method of heat application. For one reason, among others, the boiler works at a low efficiency during the summer months when the radiator section is shut off. This waste of fuel is not so important where relatively cheap fuels are used, but it is of great moment with gas.

Where possible, a much better proposition, in my view, is to convert the solid fuel boiler for central heating purposes and to install a second boiler to serve the hot water cylinder; but the cost of the conversion, additional gas boiler, and alterations to the circuit pipes might, again, rule out installations on account of high capital costs.

Swimming pools and swimming baths present a good opportunity for business at a "fivepenny" tariff; so does the communal supply of hot water in blocks of flats, large offices, &c. The same is true of slipper baths.

A swimming pool at Whyteleafe is heated by oil, and the all-in cost per therm, allowing for the cost of electricity for atomizing the oil, worked out, on the resident engineer's figures, at a fraction over 3d., say, 3¼d. To-day the figure is higher, as his reckonings were made a couple of years ago. I am sure that now he would be inclined to put in gas at a figure of round about 5d. The oil burners get messy and require a certain amount of attention; but the syndicate was determined on oil for the first pool it put down in the Croydon district, as oil plant was already on hand, having been purchased for another pool that was abandoned owing to the site being unattractive and out of the way.

One branch of "central" heating we must not ignore is the development of greenhouse heating and soil-heating. It is an attractive form of heating to enthusiastic amateur gardeners, and especially to those who are concerned with the rearing of plants which are abnormally sensitive to variations in temperature. Because these installations are relatively small, it must not be thought that they are not worth pursuing. I have often been asked whether an air-temperature thermostat is desirable in a greenhouse installation, and I can give no hard-and-fast guidance on this point. Generally speaking, however, I do not think that the capital cost of an air-temperature thermostat is warranted, from a financial point of view, as it may take the customer many years to recover, by saving in gas consumption, the amount expended on this accessory. If the installation were one of, say, 40 or 50 cubic feet per hour consumption, then in certain circumstances it might be advisable to recommend this accessory.

My Company has recently obtained a special contract for the supply of gas for heating a cinema. The estimated all-in price, exclusive of meter rent, is 6½d. per therm. And speaking of cinemas leads me to remind you that the question of the air we breathe is one which is receiving increasing attention. "The Air We Breathe" was, in fact, the title of a Paper read at the Summer Meeting of the Institution of Heating and Ventilating Engineers this year by Mr. Dufton, M.A. I was reading not so long ago that one of the Australian Gas Companies had set up its own Advisory Department on heating in consequence of the importance attached in that country to air-heating and air-conditioning, coupled with ventilation.

What of the future for large heating loads? Coke won't hold the field entirely. If we rely on the cheapness of coke we shall probably let in more oil. Gas must be given more chance by, as I have already said, increasing the range of prices for large loads. As I see things, what we regard to-day as large heating loads will, in the not distant future, appear by comparison small loads, because the field is so enormous. We have heard so much in the past of the bright future before us that we are, perhaps, apt to take matters too easily. We are assured that "the future of gas is in heat." We tell the public, "If it's heat you want, it's gas you want"; but beyond this we have not done a great deal to enhance the possibilities of turning potential business into actual business. There is a class of big installations which must, for some long time ahead (until the engineers of manufacture can give the engineers of utilization a much cheaper therm!), by virtue of its character and magnitude, be a solid fuel job; but here we are in competition, generally with low-grade coals. In a large number of cases, however, the competition is between oil, coke, and electricity. Usually, it narrows down to coke and oil (unless some special gas tariff is charged), except where electricity is offered for electric thermal storage plants supplied at night with current at a very low price. Let me say that in my view, and because of my association with the Institution of Heating and Ventilating Engineers, I do not consider that the interests of gas for large-scale heating have received sufficiently prominent representation. The oil and the electricity people have been at great pains to state their claims. They realize the vast possibilities of the big heating load, while we appear to a very large extent to have relied on the cost merits of coke to ensure business for our secondary product. Much hard spadework has to be done before gas heating is put on sure foundations.

Our primary product undoubtedly possesses many assets, and if we are to take full advantage of them it is essential that the work of developing the heating load be undertaken by a staff fully conversant with this class of work. Given the right tariff, we want the right man

to " put it over." It may be asked, " What qualifies a man to be fully conversant with this type of work? " He should have a sound fundamental knowledge of Physics and a practical knowledge of water heating. He should be fully acquainted with the design of normal installations and be able to recommend different systems to suit individual requirements—in broad principle, of course, not in detail, as the drawing-up of the full specification is a matter for the heating engineer. Such a man must have at his finger-tips competitive running costs and the disadvantages of oil and solid fuel installations. He needs unfailing energy and enthusiasm, and must be careful accurately to weigh-up estimated running costs in order that there shall be no subsequent dissatisfaction owing to actual costs being in excess of estimated costs.

This leads us to consider improving our conception of selling. Better-trained men are necessary—men who are gas salesmen in the true sense of the word, inasmuch as they are people qualified to utilize gas. It is incumbent on us to develop the technique of selling quite as much on the utilization side as we need to develop it on the recently much-stressed pyschological or " customer-reaction " side.

Finally, I wish to acknowledge my indebtedness to my General Manager for permission to use some of my Company's data in this Paper, and for the opportunity afforded me to read it. I also wish to thank my Technical Assistant, Mr. Gibbons, for his collaboration, and other friends for their suggestions and criticisms.

[The discussion on Mr. Bishop's Paper took place in private.]

Ninth Public Works, Roads, and Transport Congress and Exhibition

Last week we published abstracts of the Papers by Mr. H. R. Hems on " The Industrial and Commercial Uses of Gas," and Mr. W. J. Hadfield on " Modern Road Tars," delivered at the Congress Meeting held under the auspices of The Institution of Gas Engineers, the PRESIDENT, Mr. H. C. Smith, in the Chair. Below are reports of the ensuing discussions.

THE INDUSTRIAL AND COMMERCIAL USES OF GAS

By H. R. HEMS,

Superintendent, Industrial Heating Section, Industrial Research Laboratories, Birmingham Gas Department.

Dr. C. M. WALTER (City of Birmingham Gas Department), speaking with regard to appliances, strongly supported the plea in the Paper for collaboration with the contractors when such apparatus as gas heated boilers were being installed, in order that the flue and other arrangements were satisfactory, because gaseous fuel installations of this character had not sometimes fully realized anticipation owing to errors which had crept in as a consequence of the flue and other arrangements not having been satisfactorily allowed for in the first instance. Large quantities of town gas were now being used for central heating and in most of the large cities there were public buildings heated by gas with automatic control of the boilers. It was essential, however, that proper attention should be given to the placing of the flues inasmuch as a fuel was being dealt with which had different characteristics from those of solid fuel, and it was necessary to make arrangements for the increased quantities of water vapour produced during its combustion and to make provision for this to be condensed and led away. Manufacturers were adopting gas for industrial purposes to the increasing extent indicated in the Paper because gaseous fuel was the only one that could be completely and readily burned under a wide range of conditions of thermal concentration. In the past, insufficient attention had been given to the results that could be obtained by the suitable design of suitably applied air heaters for the heating not only of large buildings and workshops but also for the drying operations which had to be carried out on such an enormous scale in many industries. There were some excellent examples of that in Birmingham, and there were others elsewhere, all of which were operating with a very high degree of efficiency, showing that gas could be used to considerable advantage than other forms of heating for certain classes of work.

Mr. H. M. LAWRENCE, speaking as a transport manager with a fleet of 527 commercial vehicles—of which 326 were 50 cwt. vehicles and over—under his control, said that 150 of these vehicles were kept warm by the " Radright " system, and the remainder would also be dealt with in this way if a normal heating system had not already been installed before the development of low pressure steam heating. It was difficult, he said, to say much about the system, as its simplicity and easiness to handle spoke for itself. There was nothing to go wrong, as a standard gas boiler could be used, and the steam pressure was only about 4 lb. per sq.in. The cost of running was extremely cheap, being about ½d. per vehicle per hour. For the practical transport manager who either had a fleet of vehicles garaged out in the open or in a garage, the shutters of which were frequently up to allow shunting to and from the washing bay or service pits, in cold weather it was always a nightmare of doubt whether the vehicles would start in the morning—lost time being lost money. He felt that by adopting gas for generating low-pressure steam for heating lorries on the principle he had mentioned, motor transport operators were getting near to the ideal of a fleet of vehicles unhindered by delays or breakdowns, thus having a 100% earning capacity.

Dr. A. FELLS (Sheffield) said that coming as he did from an area where industrial smoke had in the past been considered almost as a necessary adjunct to industrial prosperity and having had ample opportunity to watch events in the past few years, he was able to speak with some little inside knowledge of the subject. As recently as the passing of the Smoke Abatement Act of 1926 it was argued that for certain processes in the fabrication of steel, black smoke was actually essential to the proper attainment of quality and appearance of the steel. No doubt in the past when solid fuel was the order of the day and when the furnaces in use were far from perfect in design for the purpose they had to fulfil, there was some reason in the argument, but later events had shown that, as in many other instances, a virtue was being made of a necessity. Before working for the Sheffield Gas Company he had worked for the Sheffield and District Smoke Abatement Research Committee and knew the earnest and costly endeavours of the steel firms to reduce the black pall of smoke over the industrial parts of the City. Since the passing of the 1926 Smoke Abatement Act, and particularly in the last few years, a very substantial contribution had been made to the efforts of the Sheffield steel industry and the Corporation dealing with smoke abatement, through the activities of the Sheffield Gas Company. Following many years of active interest in the subject of fuel utilization in the steel industry and after patient negotiations with steel firms, the coke oven industry and the Government, the Sheffield Gas Company, through its newly formed South Yorkshire Gas Grid, was able to offer gaseous fuel at a price which altered the complexion of things considerably. The price of gas for large scale consumption was fixed at such a figure that the cost of available or usable heat with gas-heated furnaces was actually competitive on a thermal basis with solid fuel firing. Immediately then, the old bogey of the cost of reducing the amount of smoke produced in certain steel treatment processes was removed and naturally many of the arguments favouring the necessity for black smoke were forgotten.

As trade improved, following the years of unprecedented trade depression in the steel industry, the steel manufacturers did not continue to use only the old types of furnaces fired by solid fuel. They took every advantage of the gas rendered available through the South Yorkshire Gas Grid and installed complete batteries of gas-fired furnaces for almost every re-heating and heat-treatment process known in the steel trade. They contracted for gas supplies running into hundreds of millions of cubic feet per annum, and to-day individual contracts for certain firms were over 1,000 million cu.ft. per annum. Moreover, these firms did not enter this era of gaseous fuel usage for philanthropic reasons or for any prime consideration for public health; it was done for the one reason which appealed to business men of keen judgment—it paid. Furthermore, it should be remembered that it was during the recent period of rationalization and reorganization within the steel industry that the most rapid development in the use of gas had taken place. During this period every attention had to be given to all items adding to the costs of manufacture and marketing, while realizing that present-day requirements put a premium on the quality of steel goods of a higher order than ever before. At the present time, particularly, a further factor to be considered was the demand for a very high rate of output with a guarantee that at the same time there should be no departure from the rigid specifications of quality which were demanded.

Mr. C. F. BOTLEY (Hastings) referred to the use of gas in the new Turkish Bath installation at Hastings, which, he had been assured by the Superintendent, was working most efficiently and entirely satisfactory. In that case the engineer was faced with the difficulty that he had only a very small space available for the equipment, but the difficulties in this respect were successfully overcome. The maintenance had been extremely small, amounting last year to only £5 and the consumption of gas to about 7,000 therms per annum. He added that the use of Turkish Baths in a place like Hastings varied considerably and the gas heating installation had proved of great value in providing the necessary heat at short notice.

The AUTHOR, replying to the discussion, paid a tribute to the work of Dr. Walter in connection with the development of the use of gas for industrial purposes in Birmingham, saying there was no doubt that the work done by Dr. Walter had had its effect in other parts of the country. Speaking of the re-

marks by Mr. Lawrence, he said the feature of this method of heating the radiators of motor vehicles was that it was possible to take the heat where it was wanted. He stressed the point that it was the desire of the whole of the Gas Industry to assist any public authority or any private user, domestic or industrial, to use gas in the right way. The Industry had organized itself throughout the country for disseminating all the information which was available in order to assist any district where gas could be used economically under the best conditions, and it was the desire of the Industry that the organizations which existed for this purpose could be utilized to the fullest possible extent.

MODERN ROAD TARS

By W. J. HADFIELD
(Late City Engineer, Sheffield).

Mr. A. J. LYDDON (Deputy Chief Engineer, Roads Department, Ministry of Transport) said there was a tendency in certain quarters to regard the annual surface treatment of roads as imperative, but with the improvements now being shown in tar there should not be the necessity for such frequent treatment, and this, of course, involved less interference with the users of the road.

Major TURNER (Experimental Roads Section, Ministry of Transport) said he would like to pay a tribute to the care and attention that had been given during the last ten years to the manufacture of tar. He had come into contact with a number of the larger firms and could speak with knowledge as to the care, thoroughness, consideration for research, and improvement that had been made in the production of tar. Indeed, he sometimes felt that after the great care exercised in the production of tar it should receive better treatment at the hands of users than it sometimes got. The economics of surface dressing *versus* carpets, as set out in the Paper, were incontrovertible, but there was one aspect of surface dressing which should receive consideration, and that was the habit which some road authorities had of allowing traffic to pass over roads which had been given a surface dressing of tar and chips almost immediately after the roller had finished, the result was that a number of chips were caused to fly up and hit other cars, and there had been complaints on that score. From that point of view, at all events, carpeting had an advantage.

Great Improvement in Modern Tars.

Dr. GLANVILLE (Road Research Laboratory) said he could support the Author in his statement that the tar of 1937 was a great improvement upon the tar of ten years ago and there was little doubt that this was the direct result of the application of science to its production and use. In attaining this object, in addition to the work done by surveyors, large sums had been spent on research both in the laboratories of the producing companies and in Government laboratories. The work undertaken at the Road Research Laboratory for the Road Tar Research Committee was the first co-operative research with industry started at the laboratory. He was convinced that with the normal tars supplied at the present time, an early failure or poor result from a surface dressing was largely a matter of technique of control during the operations. This did not mean, of course, that it was impossible to improve the quality of road tars still further, but at the same time it was possible, in many cases, to make better use of the present day tars. For instance, variations in the rate of spread of tar might completely swamp any possible effects due to the nature of the tar. Moreover, much depended upon the nature of the old surface to be dressed. There must be an optimum relation between the old surface, the size and nature of chippings, and the quantity and viscosity of the tar, but a really reliable criterion by which this relation could be decided was not known. Having seen some of the roads referred to by Mr. Hadfield as having had a surface dressing which was still in good condition after a period of seven years, the question obviously arose why similar results could not be obtained with all surface dressings. It was not possible to clear this position up until the significance of all the controlling factors was known. The Road Research Laboratory had participated with the Ministry of Transport in some full scale experiments for this purpose and two recent series of experimental lengths were laid for the Road Tar Research Committee in 1936 and 1937. The latter series on the Great North Road indicated the significance of the methods of preparing different types of tars. The result of the experimental dressings on the Winchester-Basingstoke road, which were laid for the Road Tar Research Committee, supported the suggestion in the Paper that the choice of suitable mixtures of gauges of stones might give a better result than the use of one size. On the problems of tarmacadam the Laboratory had carried out a little work for the Road Tar Research Committee, and here again the quantity and viscosity of the binder are shown to be important factors which must be decided by the aggregate. The temperature of mixing the materials had also been found to be of vital importance and might completely mask the possible effect of other factors.

The remarks in the Paper on thin carpets suggested that a carpet must be of extremely good quality to have an equivalent economic life to that of a surface dressing, and this indicated quite clearly that the thin carpet was not merely a substitute for surface dressing but was actually a form of construction to be used for the provision of a true running surface. These materials were at the moment in their infancy and certain proprietary materials had been used with considerable success. Some failures had also been experienced, and it appeared that there was some difficulty in determining the conditions necessary to give a long life and at the same time a continued non-slippery surface.

With regard to carpets the use of mechanical methods of laying might, with advantage, be discussed. The finished surface of a concrete road was obtained by a mechanical process in which the judgment of the operator was reduced to a minimum. On the other hand, the normal procedure with tar and bitumen carpets was to finish with a roller in which the judgment of the operator was of first importance. There was a tremendous difference between the riding qualities of a bituminous surface finished with a blading machine and those of a surface finished with a roller. The roller was invented primarily for the production of water-bound roads of the macadam type, and it might be asked whether it was not time for a new development for the finishing of roads which were highly plastic during laying. It had been found in the laboratory that small specimens of bituminous materials were much more efficiently compacted by the roller if they received a preliminary tamping. Was it possible for a tamping and blading process to be applied successfully to the laying of tar carpets?

Why Multi-Coat Tarmacadam?

Mr. W. E. CONE (British Road Tar Association) said that as one who had been privileged to serve the British Road Tar Association since its inception he was particularly gratified at the recognition which had been given in the Paper to the progressive development work of the Association from the point of view of the user.

In a Paper which he read at the Congress in 1933 he had dealt with the main factors influencing the results in the tar treatment of roads, and he was glad to see from Mr. Hadfield's Paper that he considered surface treatment was not a matter which could be left entirely to the foreman and gangers, but needed the regular supervision of responsible officers. Much the same thing could be said about the manufacture and laying of tarmacadam, and it should not be overlooked that the best quality material if badly applied would inevitably lead to failure. If any evidence were needed of the advantage to be derived from the combination of improved materials and methods of application, it would be found in the Paper of Mr. Hadfield, and it would not be difficult to supplement the examples given with others from all parts of the country. Indeed, the progress made not only paid tribute to the tar distilling industry but also to the engineers for the care and attention they now exercised in carrying out the work.

Dealing with tarmacadam, Mr. Cone said he was glad the Author had propounded the question of single-coat or multi-coat, and quite diplomatically had answered it by saying that good work was done by either method. This was undoubtedly true, but speaking as one who had consistently advocated the single-coat process in preference to all others, he wished to reinforce his earlier plea for this process on the score of greater economy and efficiency. Why it should be necessary to lay three separate coats of one size stone to obtain a surfacing to carry the traffic when the requirements could equally be met by one graded single-coat of less thickness, he had never been able to understand. He suspected that the real object of three coats was to make up for the deficiencies of the foundation, as opposed to the claim that it was done with the object of improving the riding qualities of the road. If this claim were to be taken seriously, there was a wealth of evidence to show that the good riding qualities of a road could be obtained from a single-coat surfacing of 1 in. thickness, provided that every care and attention was given to the foundation, the design of the mixture, and the laying of the material. In view of this, it was pertinent to ask what justification there was for continuing to lay tarmacadam by the multi-coat process.

Finally, Mr. Cone discussed hot-process tarmacadam. It might not be generally known, he said, that in the earlier experiments with this material it was laid in two-coats to a consolidated thickness of 6 in. As a result of the knowledge and experience gained over a number of years, it was thought that the thickness could be considerably reduced without any harmful effects, and evidence of this was forthcoming not only from the experimental lengths on the Kingston By-pass but also from a number of other lengths laid as single-coat work to a consolidated thickness of from 2 to 3 in. in different parts of the country. Hot-process tarmacadam had passed the experimental stage and its performance under very heavy traffic conditions warranted the closest attention from all those interested in the construction of modern durable non-skid roads. In these days when so much was heard about the need for new roads, one was tempted to ask for the consideration of this process as a means of securing the rapid and economical construction of durable non-skid roads.

Mr. HADFIELD, in a brief reply to the discussion, expressed his appreciation of the work being done by Dr. Glanville and added that Dr. Glanville and his colleagues investigated everything brought to their notice and did not hesitate to express views about it.

Midland Association of Gas Engineers and Managers

Autumn General Meeting

The Autumn General Meeting of the Midland Association of Gas Engineers and Managers was held at the Grand Hotel, Birmingham, on Thursday, Nov. 18—the President (Mr. H. DAVIES, of Chesterfield) occupying the chair.

In opening the proceedings, the PRESIDENT extended a very hearty welcome to Mr. H. C. Smith (President of The Institution of Gas Engineers), whom they were very pleased to have with them on that occasion; they thanked him for his presence.

The minutes of the Annual and Spring General Meetings were taken as read, after which the HON. SECRETARY AND TREASURER (Mr. J. H. Paterson, of Ludlow) announced the receipt of apologies for absence from various members and also from the Presidents and Secretaries of kindred Associations.

Mr. H. C. SMITH, invited by the President to say a few words, said it gave him very great pleasure to visit the Midland Association in his capacity of President of The Institution of Gas Engineers. They were affiliated to the Institution, and the latter appreciated the valuable work the Senior Associations were doing. On this occasion, however, it was a particular pleasure to him to be in Birmingham, for to him it was returning to his home town, where he received his early training in gas engineering. He was pleased to see there Mr. Cranmer, from whom he had his first lectures in gas engineering, and also Mr. Pearson, who was almost the first person with whom he came into contact on a gas-works. He thanked them very much for their warm welcome.

New Members.

On the proposition of the PRESIDENT, seconded by Mr. R. S. RAMSDEN (Leamington), the following were elected to membership of the Association:

W. E. Tew (Works Manager, Gloucester Gas Light Company).

S. K. Hawthorn (Saltley, Birmingham).

G. Clark (Bryan-Donkin Co., Ltd.).

M. L. Blandon (Engineer, Manager, and Secretary, Measham Gas Company).

C. Markham (Manager, Bottesford Gas Company).

P. Charles (Manager and Secretary, Wellesbourne Gas Light Coal and Coke Company).

Certificates were then presented by the President to successful candidates in the Higher Grade Examinations in Gas Engineering and Gas Supply from the Midland area.

Officers and Committee for 1938.

The following officers and new members of the Committee were thereafter elected for the ensuing year:

President.—F. Davies (Walsall).

Vice-President.—C. F. W. Rendle (Redditch).

Hon. Secretary and Treasurer.—J. H. Paterson (Ludlow).

Auditors.—G. C. Pearson (Birmingham) and A. H. Cranmer (Wolverhampton).

New Members of Committee.—E. Hardiker (Smethwick), C. F. Dakin (Cradley Heath), P. Dougall (Kidderminster).

The new President and Vice-President returned thanks for their elections, while the PRESIDENT also paid tribute to the hard work put in by Mr. Paterson on behalf of the Association.

Thereafter a Paper was presented by Mr. G. M. Gill on "The Inspection and Maintenance of Gasholders," which, together with the discussion which followed, will be dealt with in a subsequent issue of the "JOURNAL."

Southern Association of Gas Engineers and Managers

Annual General Meeting

The Annual General Meeting of the Southern Association of Gas Engineers and Managers was held at the Hotel Victoria, London, on Friday, Nov. 19—the PRESIDENT (Mr. S. E. Whitehead, of Southampton) presiding.

The minutes of the last general meeting having been taken as read and confirmed, the PRESIDENT referred to the death of an old member of the Association, Mr. R. Wardell, of Peterborough, and those present stood in silence for a moment in tribute to his memory.

Thereafter, the PRESIDENT extended congratulations, on behalf of the Association, to Mr. C. A. Deas, of Hertford, for being awarded The Institution of Gas Engineers Silver Medal for the Paper which he presented to the Southern Association last year.

Officers for 1938.

The officers for the ensuing year were then elected as follows:

President.—D. C. Cross (Lea Bridge).

Vice-President.—F. Blackburn (Devonport).

Hon. Secretary and Treasurer.—W. A. Howie (Gravesend).

Hon. Auditors.—J. Donaldson (Southborough) and J. Urquhart (Dorking).

The new officers respectively returned thanks for their elections and assured the Association of their best efforts on their behalf during the coming year.

The HON. SECRETARY announced the composition of the Eastern and Western District Committees for the year 1938 as follows:

Eastern District Committee, 1938.

Chairman.—F. J. Robinson.

Vice-Chairman.—W. H. Warren.

Committee.

C. F. Botley	W. Grogono	F. J. Robinson
*F. Blackburn	J. W. Halstead	R. H. Ruthven
G. L. Braidwood	J. F. Haseldine	V. Simmonds
G. R. Bullwinkle	L. G. Humphrys	E. F. Smallbone
T. Carmichael	J. H. Hornby	H. C. Smith
*D. C. Cross	*W. A. Howie	A. W. Sumner
F. Dawson	D. F. Irving	L. Trewby
G. Le B. Diamond	S. Lacey	W. H. Warren
J. H. Donaldson	L. J. Langford	S. E. Whitehead
H. Gage	E. L. Nicholas	

* Members *ex-officio* (Rule 9).

Hon. Secretary.—W. A. Howie.

Representatives to the Main Association (retire 1940).—H. C. Smith, W. H. Warren.

Representatives on the District Education Committee of The Institution of Gas Engineers.—G. R. Bullwinkle, D. C. Cross, H. Gage, S. E. Whitehead.

Western District Committee, 1938.

Chairman.—C. Harris.

Vice-Chairman.—R. C. Taylor.

Committee.

*F. Blackburn	R. S. Falkner	J. H. Lowther
H. H. Brown	S. E. Halliwell	J. H. Pye
J. B. Cattle	C. Harris	E. Samuel
R. J. H. Clark	H. Higham	J. Taylor
J. Hughes Cornish	*W. A. Howie	R. C. Taylor
*D. C. Cross	F. S. Hoyte	A. Thomas
W. E. Dean	S. J. Ingram	H. W. Versey
F. W. Delafield		

* Members *ex-officio* (Rule 9).

Hon. Secretary.—J. H. Cornish, Junr.

Representative to the Main Association (retires 1940).—H. Higham.

Representatives on the District Education Committee of The Institution of Gas Engineers.—C. Harris, H. Higham, R Robertson, R C. Taylor.

On the proposition of Mr. F. BLACKBURN (Devonport), seconded by Mr. L. J. LANGFORD (Tunbridge Wells), the following new members were unanimously elected *en bloc*:

New Members.

Major F. J. Bywater (South Metropolitan)	K. C. Mead (Beckton, G.L.C.)
J. R. W. Alexander (East Surrey)	L. M Wilson (South Metropolitan)
T. Brown (South Suburban)	H. V. Pye (Tavistock)
J. Grayston (Romford)	W. K. Tate (Sheerness)
F. E. Hammond (Lewes)	G. King (Milborne Port)
A. Logsdon (Farnham)	R. Summerson (Luton)
	W. F. Thorn (Bournemouth)

The PRESIDENT then presented certificates to candidates within the area of the Southern Association who had been successful in The Institution of Gas Engineers Higher Grade Examinations in Gas Engineering and Gas Supply. These will be found among the complete list of results published in the "GAS JOURNAL" for July 21, 1937.

A Paper was then presented by Mr. W. A. Bishop (Sales Superintendent to the Croydon Gas Company), entitled "Developing the Heating Load with Special Reference to Gas-Fired Central Heating Installations." This will be found on other pages of this issue.

London Juniors Have Another Night Out

Twenty-Fifth Annual Dinner

Though the Association itself is ten years older, the occasion of the "quarter-century-dinner" was marked by a more than usually enjoyable evening at the Princes Restaurant, Piccadilly, on Nov. 19, when Mr. R. N. LEFEVRE (President of the London and Southern Juniors) presided over an excellent muster of members and guests.

This year it was a "full-dress" affair, and the Association was honoured by the presence of a number of distinguished visitors, many of whose names are household words in the Gas Industry. Among these were Mr. H. C. Smith (President of The Institution of Gas Engineers), Dr. W. T. K. Braunholtz (Secretary of the Institution), Mr. Stephen Lacey (Controller of Gas Sales of the Gas Light and Coke Company), Mr. M. Milne-Watson (Deputy-Controller), Mr. R. W. Lowman (Gas Sales Manager of the Gas Light and Coke Company), Mr. G. le B. Diamond (Engineer and Manager at Folkestone and Dover), Mr. T. C. Battersby (Engineer to the Watford and St. Albans Company), Mr. E. Scears (Engineer to the East Surrey Gas Company), Mr. R. J. Milbourne (an old friend and patron of the Association), Dr. J. N. Long (Principal of the Westminster Technical Institute), and Mr. B. Brown (Vice-President of the City of Santos Improvement Company).

To Mr. F. H. G. Higton, the Hon. Secretary, much of the credit is due for the organization of so enjoyable evening—which will long be remembered as one of the most memorable Annual Dinners in recent times. As usual, Mr. Arthur Tennant was M.C., performing the introductions at the reception and subsequently becoming quite "B.B.C." with his microphone announcements at the dinner table, while the presence of Mr. T. G. Noble (understood to be one of the Association's principal exponents of the gentle art of "tickling the ivories") enabled musical honours to be accorded. Speeches, moreover, were commendably short and were almost as bright as the professional entertainments with which they were interspersed. The President of the Institution caused a good laugh by casting aside the microphone and saying, "If a gas man can't speak without the help of an electrical gadget, he'd better not try to speak at all." Later in the evening, the hardier spirits repaired to the restaurant below for dancing and a cabaret show. (We will not attempt to describe this!)

The Toasts.

The toast of "The London and Southern District Junior Gas Association" was proposed by Mr. STEPHEN LACEY, who spoke of the vital link between The Institution of Gas Engineers and the Junior Associations in respect to technical education in the Gas Industry. It would be difficult, he said, to exaggerate the importance of the part played in this matter by the Junior Associations as a whole. Concern with technical education was responsible for the birth of their Association; their founder members were students and teachers at the original City and Guilds Evening Courses in Gas Engineering and Gas Supply, while the demands of the Junior Associations were largely responsible for the inauguration of the Institution's Education Scheme some thirteen years ago. In commending this scheme to their support, Mr. Lacey did not wish to give the impression that they attached an exaggerated importance to examination qualifications—looking upon them as ends in themselves, rather than as means to an end. Indeed, they would remember that Mr. LeFevre himself blew the examination "gaff" in his Presidential Address a few weeks previously—though he must remind them that while exposing, with engaging frankness, the fallibility of examinations and examiners, he described another form of test even more devilish, because it was disguised as a parlour game. He would not be at all surprised if Mr. LeFevre had a test up his sleeve for him; but he warned him that he was preparing a jig-saw puzzle for him, which, when put together, would show him in his true colours! In conclusion, Mr. Lacey said that there was one particular characteristic of their Association which seemed to him wholly admirable—namely, they had as members all varieties of technicians—production, distribution, utilization, chemists, physicists, and technical salesmen. He gave them the toast of the Association, coupled with the name of their President.

In responding to the toast, Mr. LEFEVRE disclosed that he had been delving deeply into ancient volumes of the Technical Press, for he recounted details concerning the formation of the London and Southern District Junior Gas Association as reported in the "Journal of Gas Lighting, &c.," in November, 1902—within a few weeks of the reconstitution of The Institution of Gas Engineers as the united body which they knew to-day. Unable, apparently, to tear himself away from the ancient volume, Mr. Le Fevre went on to remark that he took the opportunity of discovering what the "&c." stood for in the title of those days—but we cannot go into that now. For twenty-five years, he said, the London and Southern Association had been the largest and possibly the keenest Junior Association in the country; it was most encouraging to find so many of the original members still interested in their activities, still willing to attend their meetings and assist them. In conclusion, the President referred to the enthusiastic support he received from all the members, as well as from his colleagues in the Industry.

Mr. S. C. WALDOCK (Senior Vice-President) proposed "The Visitors," whose presence he warmly welcomed on behalf of the Association. They were fortunate, he said, in having the friendship of the Senior members of the Industry, a fact which their Annual Dinner gave them the chief opportunity of acknowledging. After mentioning the various guests by name and referring with pleasure to the presence of the ladies, Mr. Waldock coupled the toast with the name of Mr. H. C. Smith.

Responding to the toast, the PRESIDENT OF THE INSTITUTION OF GAS ENGINEERS said how delighted they were to accept the Association's hospitality on that occasion. The Gas Industry owed a great deal to the Junior Associations, and the Industry looked to them to provide the coming men—and the amount of knowledge these men had to acquire was getting more and more every year. On behalf of all the guests, Mr. Smith thanked the Association most heartily for their hospitality, and he wished Mr. LeFevre a very happy year of office—which would lead to the success of the Association.

The Oriental Gas Company, Ltd.

The Ordinary General Meeting of the Oriental Gas Company was held at the Company's Office, Finsbury House, Blomfield Street, E.C.2 on Thursday, Nov. 18, 1937—Mr. B. W. ELLIS (Chairman of the Company) presiding.

The SECRETARY read the Notice convening the Meeting and the Auditors' Report. The Annual Report and Accounts were taken as read.

THE CHAIRMAN'S ADDRESS.

The CHAIRMAN: Before proceeding to the general business of the Meeting I have, with sorrow, formally to announce to you the death of Mr. Stanley Rainer, our Secretary, which occurred on Sept. 15, last. He had suffered from ill-health for several months, during which time he stuck to his work except when actually incapacitated. His service to the Company extended to 48 years and his loss is felt deeply by the Board and the London and Calcutta Staffs. Our sympathy goes out to his widow, for whom we have made satisfactory provision, and this, I am confident, meets with your approval. May I ask you to stand for a moment out of regard for the memory of a departed friend and devoted servant. (Those present stood for a few moments in silence.)

To fill the vacancy caused by the death of Mr. Rainer, the Board have appointed Mr. A. W. Hentsch, who has been the Secretary's chief assistant for 21 years out of a total of 27 years' service in this office. He is intimately acquainted with the Company's affairs and history during that period, and the shareholders may be assured that the London office work will continue unchanged.

If you turn to the accounts before you to-day, the increase of 2·47% in the gas sold is very creditable to the work of the staff and carries our sales above 600 millions for the first time in the Company's history; of this quantity you will be interested to know that 17·5% is due to sales for industrial purposes.

Taking the accounts *seriatim* the Capital account is the same as last year, although over £2,200 capital expenditure has been incurred and charged as usual to revenue. In the Revenue Account coal is higher by £500, more having been carbonized. Salaries are lower by £595 due to retirement and new appointments in the year under review. Wages are up by £40. Repair and maintenance is higher by £1,180. We installed two new station meters. Regarding distribution, salaries are slightly higher by reason of normal increases. Mains are lower as less work has been done. Meters show an increase of £1,020; the addition in the year of 1,193 appliances fixed and the consequent number of new consumers obtained explain this. Fittings are increased by £2,484. Last year I mentioned that we were installing "Electrolux" refrigerators. This has been continued energetically and, on June 30 last, we had 234 fixed on sale, hire, or hire-purchase. With this development wages and depreciation of stock have naturally increased. Public lamp maintenance is slightly lower, but rent, rates, and taxes are up owing to increased tax payments. Salaries of London staff are higher by £146 occasioned by increase of staff and special gratuities, necessitated by our late Secretary's illness. The two following items, stationery and general charges, are higher, as also are Bad Debts, while Law Charges are down by £20. Superannuations and Pensions show a considerable drop. Mr. Garsed's retirement in 1936 largely accounts for this, but against it there is a small rise in Calcutta pensions. Gratuities are lower, a smaller number of workmen having left in the year. Passages are lower; this is always a fluctuating item. Insurances are lower owing to reduction of premiums.

On the Receipts side, although we have sold 14½ million cu.ft. more, our revenue under this head is only £511 more. Last year I said we proposed to devote future profit to, among other things, reduction in price, and we reduced our price to the hospitals by 8 annas per 1,000 cu.ft. Beyond this much of our increased sale has been industrial gas supplied at a lower rate.

Meter rentals are lower. Here again, we have made substantial reductions in what is a necessary, but perhaps irritating, charge to consumers. Stoves and appliances rental is up by £266. Of this, stove rents alone are down by £365 as reductions were made in their rental at the same time as in that of meters, but a slight rise in geysers, and the new rental from refrigerators combined, account for the rise over all. The improvement in the revenue from coke and breeze is marked, a higher price being obtained, although a smaller quantity was sold. This rise in price is continuing, and I have every hope that next year's accounts will show a further improvement under this head. The drop in tar receipts is occasioned by our having sold less at a fractionally lower rate. This is always a difficult market and we are subject to influence not under our own control. We do not belong to the Tar Producers' Association, but we work in entire amity with them. We regard our tar as superior for purposes of chemical treatment and at our General Manager's suggestion we are arranging for its sale under a protecting trade mark. The last two items call for no remark. The total receipts are up by £92 and the total expenditure up by £2,250, resulting in a decrease in trading profit of £2,157.

Turning now to the Net Revenue Account, bank interest is higher by £40 and interest on investments by £85, an addition to our invested funds having been made in April last. Exchange profit is lower by £828 owing to a decrease in remittances of £7,500 during the year. This latter is more than accounted for by our large purchase of refrigerators for which payment is made locally. The carry-forward is increased by £11,898 as we have not placed any further sum to reserve, preferring to keep our balance in a fluid condition at present and readily available for any calls upon it.

With regard to the Balance-Sheet, you will have noted an increase of £1,814 in the amounts due by the Company. In view of the impending rise in prices of all our materials the Board made large purchases in advance of the Company's requirements. Some of these were shipped just before the close of our financial year and the settlements for them came into the current year. The same was the case with other goods purchased in Calcutta. We are keenly alive to the advisability of purchasing in India as much of our stores and material as possible. We obtain all our cast-iron pipes and much of our fireclay goods locally and have recently for the first time purchased galvanized iron tubing from Indian sources.

On the assets side cash is lower by £7,357 due to the purchase of refrigerators, to which I have referred.

The amount invested is raised by the purchase last April of Funding Loan. Stores are higher by £10,214 by the purchase of refrigerators and other material bought in advance of actual requirements as I have said. Amounts due to the Company are higher by £1,170, partly due to Insurance premiums paid in advance.

During the year buildings, plant, and machinery have been kept in thorough repair with renovation and additions where necessary. Among these is the erection of a large water storage tank, improving the efficiency of the washing and scrubbing plant, a most desirable addition in a tropical country.

The mains and services are in good condition and rather over 3 miles of new mains have been laid, mostly in the south of the City, where development is proceeding.

Our relationship with the Municipality and other Public and Public Utility bodies has been wholly amicable. As regards the Public Lighting the fixing of new and discontinuance of old lamps has resulted in a drop of 10 lamps in our total, which now amount to 19,211. Against this we have 56 temporarily discontinued and await instructions to re-erect and re-light them in new positions. There exists in Calcutta, as in the case at home in Britain, a strong inclination towards the transfer of street lighting to electricity without regard to the record of gas for trustworthiness of supply in time of cyclones and floods. To meet this every effort on the part of our staff is called for and is forthcoming, and they have all the support the Board can give. There has been street lighting by gas in Calcutta for 80 years, and we are confident that with efficient maintenance and the provision of up-to-date lanterns and burners, Calcutta can have lighting by gas equal to any City of the Empire.

The increase in new gas appliances fitted of 1,193 is higher than any increase of recent years. The new showroom (views of which we now circulate among you), coupled with the enterprise of our staff, is responsible for this welcome development.

During the early part of the year trouble among our men arose entirely fomented by political agitation, causing great anxiety to Mr. Savage. He took every precaution in view of a threatening strike, which, however, did not occur owing to his able handling of the position. A similar upheaval has occurred since last June, aimed, not at us alone, but at all the Utility Companies. This has been met with success by Mr. Gladstone, our Acting Manager, on the lines pursued by Mr. Savage.

Although there has been no outbreak of any nature on a large scale there has been a considerable amount of illness among our European staff and this I shall refer to later.

Before moving the adoption of the Report and Accounts, I shall be pleased to answer any question arising out of them by shareholders.

There being no questions, the CHAIRMAN moved: "That the Report of the Directors and Statement of Accounts now submitted be received and adopted."

Mr. STANLEY H. JONES seconded, and the motion was unanimously adopted.

The CHAIRMAN then proposed the following resolution: "That a final dividend of 4½%, free of income-tax, be declared, making 8%, free of income-tax, for the year ended June 30, 1937, and that the Warrants for the same be sent by post to Proprietors on Nov. 18, 1937."

Mr. W. G. BRADSHAW seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed the re-election to the Board of

Mr. Hugh Henderson Macleod and Mr. William Graham Bradshaw.

Mr. STANLEY H. JONES seconded and the motion was carried unanimously.

Mr. E. GARSED proposed, and Col. PARKER seconded, the re-election of Messrs. S. W. Savage and F. J. Bradfield as Auditors to the Company for the ensuing year at the same remuneration as last year.

The motion was carried unanimously.

The CHAIRMAN then proposed a hearty vote of thanks to the staffs in Calcutta and London for the manner in which they had carried out their duties during the past year. He remarked that the General Manager of the Company, Mr. Savage, had been over here on leave during the year and had spent part of it in England. Unfortunately, on his arrival he was seized with the development of a serious trouble which had been bothering him, but fortunately it had yielded to treatment. Part of the time he had been on leave, Mr. Savage had unstintingly devoted to the service of the Company. He had been in constant discussion with the Board and had visited various works here in the interest of the Company. That was a trait which was common to all the staff of the Company when home on leave. Mr. Savage was now back again in Calcutta and had taken up the reins of management again which had been so ably handled in his absence by Mr. Gladstone, the Acting Manager. As to the other members of the staff, the Chairman drew special attention to the work of Messrs. Lyle, Atkinson, Smith, Bathgate, and Pope, who, he said, had carried out their duties in an admirable manner during the year. There had been no outbreak in Calcutta, but there had been a good deal of seasonal sickness from which they had all suffered and those who had lived in Calcutta were fully aware of the discomforts under which the staff sometimes had to labour. Mr. Pope and Mr. Lyle had spent a good deal of time on the lay-out of the new showroom—views of which had been distributed among those present—and he believed everybody would agree that the results justified the efforts that had been made.

Turning to the London office, the Chairman spoke of the efficient manner in which Mr. Hentsch had taken over the office of the late Secretary, Mr. Rainer, and said the Board had every confidence in Mr. Hentsch and Miss Barron, both of whom had had to do a great deal of extra work which had involved the loss of holidays owing to the illness and passing away of Mr. Rainer.

Mr. STANLEY H. JONES seconded the vote of thanks, which was accorded with hearty acclamation.

Mr. HENTSCH briefly expressed his thanks on behalf of the staff in Calcutta and London.

On the motion of Col. PARKER, seconded by Mr. F. J. BRADFIELD, a hearty vote of thanks was accorded to the Chairman and Directors for their services during the past year.

Trade Notes

Incandescent Heat Company, Ltd.

An extensive demonstration shop which is incorporated in the works of the Incandescent Heat Company, Ltd., Cornwall Road, Smethwick, Birmingham, has recently been completed. In this shop all standard furnaces are shown under actual working conditions. Small demonstration units of the firm's latest types of special purpose furnace are also on exhibition. Any furnace in the showroom can be demonstrated provided sufficient notice is given. Visitors may bring their own specimens to see them treated.

The Masseeley Advertising Unit.

The Gas Light and Coke Company were the recipients of a special award in a competition recently organized by Messrs. Masson Seeley & Co., Ltd., Masseeley Buildings, 14, Howick Place, S.W. 1, to illustrate the artistic and commercial possibilities of the Masseeley Advertising Unit. An exhibition comprizing winning and other meritorious entries submitted for this national contest was opened on Nov. 12 by Sir Charles Higham. The exhibition remained open until Nov. 24 and aroused great interest among all business men concerned at all with the distribution or sale of merchandise.

The Masseeley Advertising Unit is primarily a new method of colour printing, as distinctive in its way as collotype, specially suitable for individual jobs, short runs, and multi-coloured work required at very short notice. But it is something more. It can cut out and fashion original screens and display stands on which the actual merchandise can be shown in association with a powerful sales message, or enhanced by special lighting effects. It can accommodate every kind of lettering, all types of pictorial effect, and every possible colour combination; and it can do its work as effectively on such varied materials as wood, fabric, leather, and celluloid, as on card or paper.

Gas Poker Burners.

An article on "Gas Ignition for Smoke Prevention" by Mr. John Roberts, D.I.C., recently appeared in *Colliery Engineering*, in the course of which the Author draws attention to the increasing popularity of the gas poker as a means of igniting domestic fires. He attributes that popularity to two reasons—viz., the convenience of gas for that purpose and the fact that the ignition of fuels which are normally more difficult to ignite than ordinary household coal is considerably accelerated. He then goes on to deal with the various types of gas poker, paying particular attention to the double pronged type designed by Mr. G. M. Gill. The Author has used a poker of this type for the past two years in testing various types of domestic

Stanton-Wilson Jointed Pipes rounding bend without Specials
STANTON
SPUN IRON PIPES
STANTON
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STANTON
Ductility and Toughness Greatly Increased
Complete elimination of "chill" and subsequent annealing, increased resistance to shock and impact, and a marked advance in ductility and toughness are qualities found ONLY in pipes made by the Delavaud-Mairy ferro-silicon process.
Stanton Spun Iron Pipes are now not only stronger and better than pipes made by any other process, but they are also a considerable improvement over pipes previously cast by us in metal moulds without the use of the ferro-silicon process.
When laying metal-cast spun pipes, make sure they are made by the Delavaud-Mairy ferro-silicon process, the only known method of eliminating "chill" and subsequent annealing.
The Stanton Ironworks Company Limited,
Near Nottingham

fuel, mainly of the smokeless variety, but on using it with a coal of about 20% volatile matter it was at once noted that practically the whole of the smoke was consumed from the outset. It was subsequently used with several different high-volatile smoky coals with equally striking results. The article is concluded with various data, including ignition times and gas consumptions. The poker designed by Mr. Gill and described in the article is sold by Messrs. Falk, Stadelmann, & Co., Ltd., 83-93, Farringdon Road, London, E.C. 1, under the name of the "Double" poker.

"Newbridge" Gas Pistols in Christmas Cartons

Last year was the first occasion on which the Horstmann Gear Company, Ltd., supplied their "Newbridge" gas pistol in a Christmas carton, and the demand for these from gas undertakings was most gratifying. This year the cartons, already posted to the Industry, are of attractive design in seasonable colours, and pistols are supplied in them without extra charge. The "Newbridge" pistol is undoubtedly a most useful and attractive gift, providing that additional convenience so much appreciated by the users of cookers.

M.A.N. Waterless Gasholders.

Records show that at various times during the evolution of the gasholder attempts were made to dispense with water sealing. It was not, however, until 1914 that a truly practical waterless gasholder came into being; and although in the succeeding years the M.A.N. waterless holder made gradual but sure progress, it was not until 1927 that Britain saw its first holder of this type. In that year the Ipswich Gas Light Company installed a 2-million cu.ft. M.A.N. holder. Within a few years, several holders of that type had been erected by the Gas Light and Coke Company.

The Waterless Gasholder Company, Ltd., 13, Rood Lane, London, E.C. 3, have published a most interesting illustrated brochure on this subject, giving many details of the construction and operation of M.A.N. holders, for which they are British Empire Concessionaires. Copies will be gladly supplied to interested parties upon application to the Waterless Gasholder Company or to the following contractors: Messrs. R. and J. Dempster, Ltd., Manchester; R. Dempster & Sons, Ltd., Elland; Clayton Son, & Co., Ltd., Leeds; and E. Cockey & Sons, Ltd., Frome.

C.O.L. Continuous Vertical Retorts.

Builders of modern carbonizing plant both for the Gas Industry and coal and steel interests, Gas Chambers and Coke Ovens, Ltd., Artillery House, Westminster, S.W. 1, have to date installed plants with a total output of 30 million cu.ft. per diem, the daily output capacity of the plants ranging from 5½ down to ½ million cu.ft. These plants have been installed for such clients as the Gas Light and Coke Company, Portsmouth Gas Company, Vancouver Gas Department, Metropolitan Gas Company of Melbourne, and United Kingdom Gas Corporation.

We have received from the Company some details of these installations, and it is interesting to note that the first small plant built by them was at Brough, Yorkshire, where it has been working for four years without interruption. The second plant, an installation of six 60 in. retorts, has been in operation at Abergavenny for over a year and this also has given the greatest possible satisfaction working with relatively highly-swelling South Wales gas coals. The thermal outputs per ton of coal carbonized are 85 at Brough and 87 at Abergavenny, and, as a result of the success of these two plants, an eminent firm in France has acquired the Company's licence for the C.O.L. system in that country and its colonies.

Western Juniors at Torquay

Hollacombe Works and Showrooms Inspected

On Nov. 16 the Western Junior Gas Association had another successful meeting at Torquay. Members assembled at the Hollacombe Gas-Works, where parties were formed for inspection of the plant, while others went to see mainlaying operations near the Works.

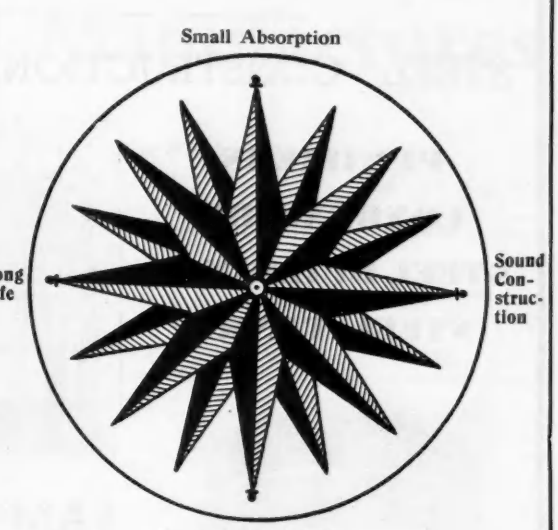
Nearly the whole of the gas is made in Glover-West Continuous Vertical Retorts, from sea-borne South Yorkshire coals. The new automatically-operated Humphreys and Glasgow water gas plant attracted a good deal of attention. Later in the afternoon the showrooms were inspected and the general impression was that it would be difficult to imagine a finer and better arranged showroom. Tea was served through the courtesy of the Chairman and Directors of the Torquay and Paignton Gas Company, and the thanks of the Association were expressed by the President, Mr. J. E. Akroyd (Swindon, G.W.R.).

Mr. R. C. Taylor, Director, Engineer, and Manager, said he was pleased to see such a good attendance and also to know that the visit had been so much enjoyed. He apologized for the absence of the Chairman, Major R. P. Kitson, and Deputy-Chairman, Mr. R. Beynon.

Following tea, a Paper on "Some Practical and Theoretical Aspects of Crude Benzole Recovery" was presented by Mr. F. A. Butt, A.M.I.Chem.E., Chief Chemist of the Torquay and Paignton Gas Company.

During the course of the meeting Mr. R. C. Taylor was elected an Honorary Member of the Association.

All the Cardinal Points



ARE CAREFULLY WATCHED IN THE CONSTRUCTION OF OUR METERS

OUR HIGH CAPACITY METERS

are specially designed for their work and register accurately, with a minimum of pressure loss under

The most severe tests

MANY SPECIAL AND DISTINCTIVE FEATURES ARE INCORPORATED AND ARE WELL WORTH YOUR EXAMINATION.

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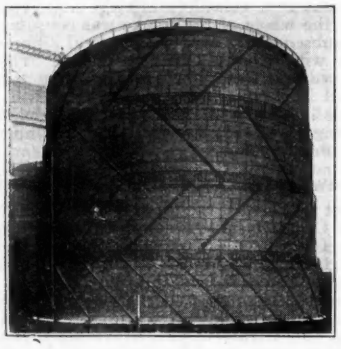
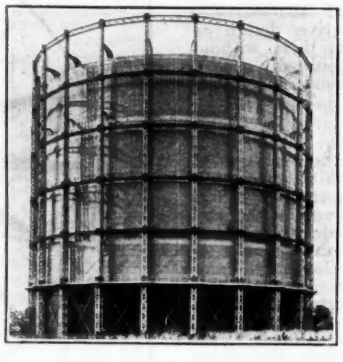
GASHOLDERS

GUIDE FRAMED SPIRAL WATERLESS

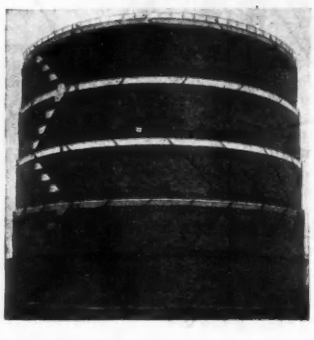
STEEL CONSTRUCTIONAL WORK



PURIFIERS
CONDENSERS
STEEL BUILDINGS
STEEL TANKS



COAL AND COKE
HANDLING PLANT
SCRUBBERS
WASHERS



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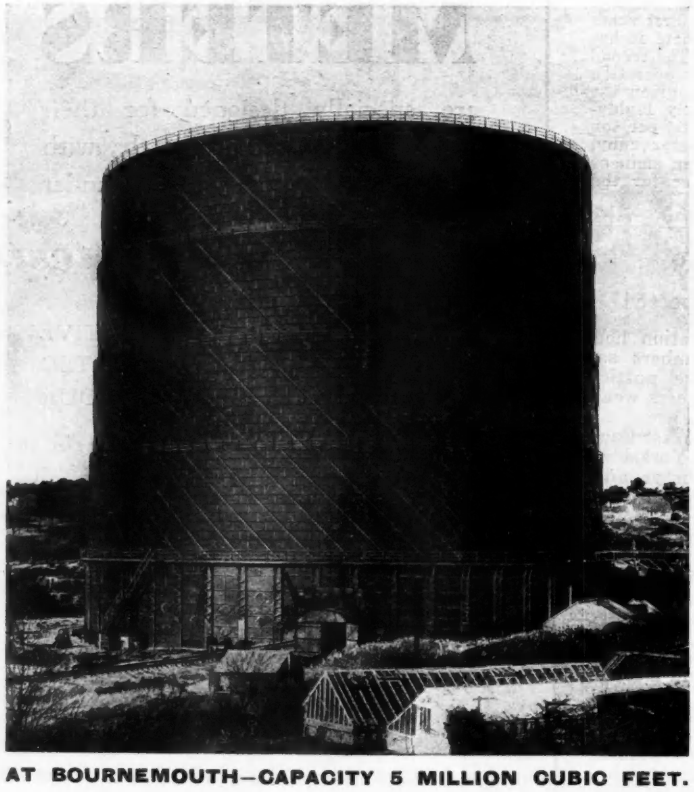

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HOLDER
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Gas Markets and Manufactures

Stock Market Report

(For Stock and Share Lists, see later pages)

The chief feature of last week's business on the Stock Exchange was the heavy amount of liquidation which took place in practically all sections. Buying orders were few, and in the absence of support prices in many directions suffered severely. Even British Funds, which have successfully weathered several bad shocks during past weeks, could not combat the general depression and closed fractionally lower. Despite the good traffic receipts so far this year, which have given rise to the possibility of some increase in dividend disbursements, home rails developed further weakness. Industrials were without support and prices sagged, while oils and rubbers shared a similar fate.

The Gas Market remained calm and featureless. In common with other sections, the volume of business recorded was quite small. It will be noticed, however, that whereas elsewhere nearly all prices were marked down, this market was fortunate in that it was able to record a few increases. These included a further rise in Gas Light units, which closed 6d. higher at 25s. 6d., and small gains in Imperial Continental and South Metropolitan. Apart from the usual *ex* div. markings at about this time of the year, the only fall above a point occurred in Newcastle units at the local Exchange with a drop of 6d. to 22s. 9d.-23s. 3d. As a general rule the stock of a provincial company quoted on the home exchange, by reason of its local popularity, stands two or three points higher than on the London Exchange. It is interesting to note, therefore, that in the case of the Newcastle units these are now quoted in London at 22s. 6d.-24s. 6d., the middle market price being 6d. higher than at Newcastle, and a parcel is on offer in London at 23s. 9d. to give a yield of £4 10s. 9d.%. The highest price recorded in London last year was 28s. 3d.

A good line in preference stocks at present available is that of 50,000 United Kingdom Gas Corporation 4½% 1st cumulative £1 shares at 20s. 6d. *ex* div., free of stamp, yielding £4 7s. 9d.%.

Current Sales of Gas Products

The London Market for Tar Products.

Nov. 22.

Prices of tar products remain steady at the following levels:

Pitch, 38s. per ton f.o.b.
Creosote, 6d. to 6¼d.
Refined tar, 3¾d.
Pure toluole, 2s. 4d. to 2s. 5d.; pure benzole, 1s. 9d.; 95/160 solvent naphtha, 1s. 7d. to 1s. 8d.; 90/160 pyridine, 11s. to 12s.; all per gallon naked at makers' works.

Tar Products in the Provinces.

Nov. 22.

The average prices of gas-works products during the week were: Gas-works tar, 24s. 3d. to 29s. 3d. Pitch—East Coast, 37s. to 38s. 6d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 37s. to 38s. 6d.* Toluole, naked, North, 1s. 8d. to 1s. 9d. Coal tar, crude naphtha, in bulk, North, 8d. to 8½d. Solvent naphtha, naked, North, 1s. 5½d. to 1s. 6d. Heavy naphtha, North, 1s. 3d. to 1s. 3½d. Creosote, *ex* works, in bulk, North, liquid and salty, 5d. to 5½d.; low gravity, 4⅝d. to 4½d. Heavy oils, in bulk, North, 5d. to 5¼d. Carbolic acid 60's, 4s. 1½d. to 4s. 3d. Naphthalene, £14 to £17. Salts, 80s. to 85s., bags included. Anthracene, "A" quality, 4½d. to 4¾d. per minimum 40% purely nominal; "B" quality unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 20.

Business is slow and, whereas in certain cases there is a tendency to reduce quotations, on the whole distillers are maintaining their prices.

Crude gas-works tar.—Actual value is 37s. to 38s. per ton *ex* works in bulk.

Pitch is changing hands at round 30s. to 32s. 6d. per ton f.o.b. Glasgow for export, and 30s. per ton *ex* works in bulk for home trade.

Refined tar remains dull at 3d. to 3¼d. per gallon free on rails for export, and 3½d. to 3¾d. per gallon *ex* works in buyers' packages for home trade.

Creosote oil.—With enquiries quite numerous prices are steady as under: Specification oil, 5½d. to 5⅝d. per gallon; low gravity, 6¼d. to 6½d. per gallon; neutral oil, 5¼d. to 5½d. per gallon; all *ex* works in bulk.

Cresylic acid.—Only a small business is being conducted, but distillers have considerable faith in the market and are maintaining quotations as under: Pale, 97/99%, 3s. 6d. to 3s. 8d. per gallon; dark, 97/99%, 3s. 3d. to 3s. 6d. per gallon; and pale, 99/100%, 4s. to 4s. 6d. per gallon; all *ex* works in buyers' packages.

Crude naphtha is changing hands at round 6d. to 6½d. per gallon *ex* works in bulk, according to quality and district.

Solvent naphtha remains firm at 1s. 5d. to 1s. 6d. per gallon for 90/160 grade, and 1s. to 1s. 1d. per gallon for 90/190 heavy naphtha.

Motor benzole is valued at 1s. 4d. to 1s. 4½d. per gallon.

Pyridine is nominal at 11s. to 12s. per gallon for 90/160 grade, and 12s. to 13s. per gallon for 90/140 grade.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole	0	9½	to	0	10	per gallon at works
Motor "	1	3	"	1	3½	" " "
90% "	1	4	"	1	4½	" " "
Pure "	1	8	"	1	8½	" " "

Contracts Advertised To-Day

Gas Oil.

Bexhill Gas Department. [p. 690.]

Gas-Works Buildings.

Blackpool Gas Department. [p. 690.]

Pipes and Specials.

Atherton Gas and Water Department. [p. 690.]

Stores.

Dewsbury Gas Department. [p. 690.]

Overseas Opportunities

Johannesburg.

H.M. Trade Commissioner at Johannesburg reports that the Johannesburg City Council is calling for tenders (Tender No. 715) for the supply, delivery, and erection of

8 floating gas collectors, each 59 ft. 2 in. by 29 ft. 2 in. overall size, of copper bearing mild steel construction as used in common gas holder practice, for sludge digestion tanks.

Tenders, endorsed "Contract No. 715—Mild Steel Gas Collectors," should be addressed to the Town Clerk, Municipal Offices, Johannesburg, by whom they will be received up to noon on Dec. 18, 1937. (Ref. T. 28297/37.)

THE GLOVER-WEST SYSTEM

GETS THE MOST OUT OF THE COAL

The ease with which heat can be concentrated or distributed at will in the Glover-West vertical retort setting makes possible just that heat treatment required by the particular gas coals available. And this applies to recognised carbonizing coals throughout the world. Many of them have been investigated under full-scale working conditions in the test installation on the research gas plant at our Manchester works.

GLOVER-WEST

CONTINUOUS CARBONIZATION IN VERTICAL RETORTS

WEST'S GAS IMPROVEMENT CO. LTD • MILES PLATTING • MANCHESTER 10

STOCK AND SHARE LIST

Official Quotations on the London Stock Exchange

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Nov. 19.	Rise or Fall on Week.	Transaction Lowest and Highest Prices During the Week.
1,767,439	Stk.	Sept. 6	8	8	Alliance & Dublin Ord. ...	165—170	...	167½
374,000	,,	June 21	4	4	Do. 4 p.c. Deb. ...	95—100	...	...
558,890	,,	Aug. 9	7	7	Barnet Ord. 7 p.c.	158—163	...	...
300,000	1	Oct. 4	1/9⅔	1/4⅓	Bombay, Ltd.	26/—28/-	...	27/-
179,915	Stk.	Aug. 9	9½	9½	Bournemouth sliding scale ...	200—205	...	...
590,407	,,	,,	7	7	Do. 7 p.c. max. ...	158—163	...	159
493,960	,,	,,	6	6	Do. 6 p.c. Pref. ...	133—138	...	...
50,000	,,	June 21	3	3	Do. 3 p.c. Deb. ...	79—84	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	98—103	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	115—122	...	...
357,900	,,	Aug. 9	7½	7½	Brighton, &c., 6 p.c. Con. ...	150—155	...	...
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	133—138	...	131½—136
205,500	,,	,,	6	6	Do. 6 p.c. 'B' Pref.	127—133	...	...
855,000	,,	Sept. 20	8	7	British Ord.	145—150	...	145—145½
100,000	,,	June 21	7	7	Do. 7 p.c. Pref.	140—145	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. 'B' Cum. Pref.	110—115	...	...
120,000	,,	June 7	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	98
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	102—107	...	...
450,000	,,	,,	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1⅛—2⅛	...	...
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1⅛—3⅛	...	...
150,000	Stk.	June 21	4½	4½	Do. 4½ p.c. Deb. ...	79—84	...	...
626,860	,,	July 19	6	6	Cardiff Con. Ord.	125—130	...	...
237,860	,,	June 7	5	5	Do. 5 p.c. Red. Deb.	107—112	...	...
98,936	1	Oct. 4	2/-	2/-	Colombo Ord.	1⅞—1⅞*	...	...
24,510	1	,,	1/4⅜	1/4⅜	Do. 7 p.c. Pref. ...	23/6—25/6	...	...
739,453	1	Oct. 4.	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	17/—19/-	...	...
296,144	1	,,	1/3·30	1/3·30	Do. 8 p.c. Pref.	22/—24/-	...	...
1,775,005	Stk.	Aug. 9	5	5	Commercial Ord.	82—87	−1	82½—86
620,000	,,	June 7	3	3	Do. 3 p.c. Deb. ...	74—79	...	...
286,344	,,	Aug. 23	5	5	Do. 5 p.c. Deb. ...	113—118	...	115
807,560	,,	Aug. 9	7	7	Croydon sliding scale ...	140—145	...	144½
644,590	,,	,,	5	5	Do. max. div.	108—113	...	...
620,385	,,	June 21	5	5	Do. 5 p.c. Deb.... ...	113—118	...	...
239,000	,,	Aug. 9	5	5	East Hull Ord. 5 p.c....	98—103	...	...
185,355	,,	Aug. 9	6	6	East Surrey Ord. 5 p.c. ...	120—125	...	...
176,211	,,	June 7	5	5	Do. 5 p.c. Deb. ...	113—118	...	...
250,000	1	Nov. 15	7	4	Gas Consolidation Ord. ...	19/6—21/6*	−/6	...
250,000	1	,,	4	4	Do. 4 p.c. Red Cum. Pref.	18/6—20/6*	−/6	...
19,255,284	Stk.	Aug. 9	5⅔	5⅔	Gas Light & Coke 4 p.c. Ord.	25/—26/-a	+/6	25/—25/10½
2,600,000	,,	,,	3⅓	3⅓	Do. 3⅓ p.c. max.	83—86	...	85½
4,477,106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	99—102	...	100½—102
2,993,000	,,	July 5	...	3¾	Do 3¾ p.c. Red. Pref.	101—103	...	102—102¾
8,602,497	,,	May 24	3	3	Do. 3 p.c. Con. Deb. ...	78—81	...	79—81
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	112—115	...	113½—114½
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb....	111—114	...	112—113½
700,000	,,	Sept. 6	3½	3½	Do. 3½ p.c. Red. Deb....	94—99	...	96—97½
270,466	,,	Aug. 23	6	6	Harrogate New Cons. ...	115—120	...	...
213,200	,,	Aug. 9	6	6	Hornsey Con. 3½ p.c. ...	118—123	...	118½
5,600,000	,,	Nov. 1	12	8	Imperial Continental Cap. ...	138—143	+1	140—143
223,130	,,	July 19	3½	3½	Do. 3½ p.c. Red. Deb. ...	89—94	...	91½
285,242	,,	Aug. 9	8½	8½	Lea Bridge 5 p.c. Ord. ...	170—175	...	...
75,000	,,	May 24	†10	†10	Malta & Mediterranean ...	150—160	...	153½—154½
392,000	—	Oct. 1	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	100—103	...	...
231,978	Stk.	Aug. 23	5	5	M.S. Utility 'C' Cons. ...	101—106	...	...
968,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	96—101	...	96½—97
360,075	,,	June 21	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
148,955	,,	,,	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
675,000	,,	Nov. 15	†9	†6	Montevideo, Ltd.	88—93*	−3	...
250,000	,,	Aug. 9	7½	7½	North Middlesex 6 p.c. Con.	150—160	...	...
396,160	,,	Aug. 9	5	5	Northampton 5 p.c. max. ...	110—115	...	...
300,000	,,	Oct. 18	†7	†9	Oriental, Ltd....	153—158	...	...
468,537	,,	June 7	8	8	Plymouth & Stonehouse 5 p.c.	157—162	...	...
621,667	,,	Aug. 9	8½	8½	Portsmouth & Gosport Cons.	164—169	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	104—109	...	...
73,350	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
441,275	1	Sept. 20	1/1½	1/1½	Severn Val. Gas Cor. Ld. Ord.	21/6—23/6	...	22/-
460,810	1	,,	-/10⅛	-/10⅛	,, ,, 4½ p.c. Cum. Pref.	19/6—21/6	...	19/9
133,201	Stk.	Aug. 23	5	8⅛	Shrewsbury 5 p.c. Ord. ...	130—135	...	...
1,371,752	1	Sept. 6	1/2⅝	1/2⅝	South East'n Gas. Cn.Ld. Ord.	23/—25/-	...	...
871,636	1	,,	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pref.	20/—22/-	...	...
498,818	1	,,	4	4	Do. 4 p.c. Cum. Pref. ...	18/—20/	...	...
450,000	Stk.	Aug 9	4	4	Do. 4 p.c. Deb.	99—102	...	...
150,000	,,	,,	3⅓	3⅓	Do. 3½ p.c. Red. Deb. ...	96—99	...	...
6,709,895	,,	Aug. 9	6	5	South Met. Ord.	101—103	+½	101¾—103
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	131—136	...	...
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	98—101	...	100—101
1,895,445	,,	June 21	3	3	Do. 3 p.c. Deb. ...	75—80	...	78½
1,000,000	,,	July 5	5	5	Do. 5 p.c. Red. Deb....	110—113	...	111½
1,543,795	,,	Aug. 9	6	6	South Suburban Ord. 5 p.c....	120—125	...	121½—122½
512,825	,,	,,	5	5	Do. 5 p.c. Pref....	110—115	...	111½
500,000	,,	,,	4	4	Do. 4 p.c. Pref....	95—100	...	...
250,000	,,	,,	...	§18/9	Do. 3½ p.c. Red. Pref.	98—101	...	...
888,587	,,	June 7	5	5	Do. 5 p.c. Deb....	115—120	...	...
250,000	,,	,,	4	4	Do. 4 p.c. Deb....	98—101	...	...
200,000	,,	Sept. 20	...	3½	Do. 3½ p.c. Red. Deb.	94—99	...	...
427,859	1	Nov. 1	1/2⅜	9⅜	S. Western Gas & Water Ord.	18/6—20/6	...	19/-
160,523	1	,,	-/10⅛	-/10⅛	Do. 4½ p.c. Red. Cum. Pf.	19/6—21/6	...	20/10½
110,000	Stk.	June 21	4	4	Do. 4 p.c. Red. Deb. ...	97—102	...	...
750,541	,,	Aug. 9	5½	5	Southampton Ord. 5 p.c. ...	111—116	...	114
148,836	,,	June 7	4	4	Do. 4 p.c. Deb.	97—102	...	...
350,000	,,	Aug. 23	5½	5½	Swansea 5½ p.c. Red. Pref. ...	110—115	...	...
94,000	,,	June 7	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	...
1,076,490	,,	Aug. 9	6⅔	6⅔	Tottenham and District Ord.	133—138	...	...
409,835	,,	,,	5½	5½	Do. 5½ p.c. Pref....	121—126	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	110—115	...	...
371,850	,,	June 7	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
888,629	1	Oct. 4	6	4	U. Kingdom Gas Cor. Ord.	20/—22/-	...	20/3—20/9
968,841	1	Nov. 15	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	20/—22/-*	...	...
745,263	1	June 7	4½	4½	Do. 4½ p.c.2nd Non-Cum.Pf	17/—19/-	...	...
1,000,000	Stk.	Sept. 20	3½	3½	Do. 3½ p.c. Red. Deb. ...	96—99	...	97¾
373,939	,,	Aug. 9	7	7	Uxbridge, &c., 5 p.c. ...	138—143	...	...
133,010	,,	,,	5	5	Do. 5 p.c. Pref. ...	109—114	...	...
1,371,138	,,	Aug. 9	7	7	Wandsworth Consolidated ...	140—145	...	...
1,620,615	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
500,000	,,	,,	4	4	Do. 4 p.c. Pref. ...	99—102	...	100½—100¾
1,343,964	,,	June 7	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
383,745	,,	,,	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
558,342	,,	Aug. 9	7	7	Watford and St. Albans Ord.	138—143	...	141½
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	109—114	...	...
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	121—126	...	...
200,000	,,	June 7	4	4	Do. 4 p.c. Red. Deb.	97—102	...	...
100,000	,,	,,	3½	3½	Do. 3½ p.c. Red.Deb.	95—100	...	...

a.—The quotation is per £1 of Stock * Ex div. † Paid free of income-tax. ‡ For year. § Actual.

Stock and Share List continued overleaf.

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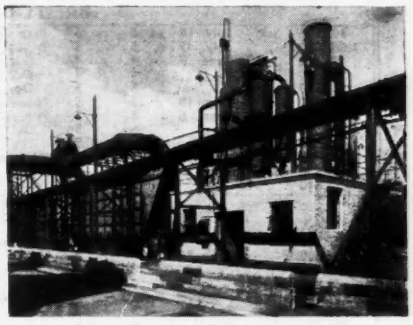
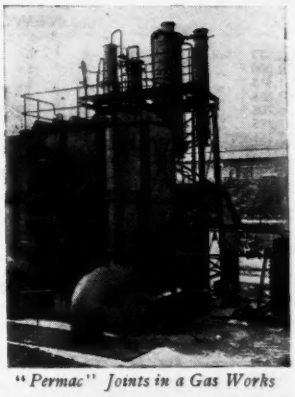
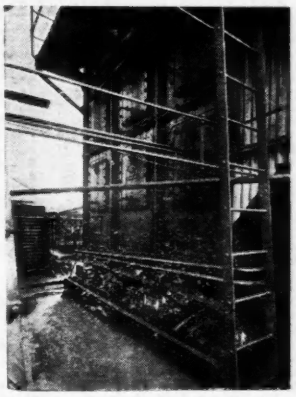


"Permac" Joints in a Gas Works.



"Permac" Joints in a Gas Works



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STOCK AND SHARE LIST—Cont.

Stocks Officially Quoted on Provincial Exchanges

Issue. £	Stock or Share	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME	Quotations. Nov. 19.	Rise or Fall on Week.	Transactions Lowest and Highest During the Week.
BRISTOL EXCHANGE.								
347,756	Stk.	July 19	6	5	Bath Cons.	120—122	...	...
1,667,250	,,	July 19	5	5	Bristol, 5 p.c. max.	115½—117½	...	...
120,420	,,	June 7	4	4	Do. 1st 4 p.c. Deb. ...	100½—102½	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	100½—102½	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	120—123	...	...
274,000	,,	July 19	5	5	Newport (Mon.) 5 p.c.max. ...	101—106	...	...
13,200	12	Sept. 6	8	7	Pontyp'l Gas & W. 10 p.c. 'A'	13—14	...	...
13,600	10	,,	6	5	Do. 7 p.c. 'B'	11½—12½	...	...
40,000	10	,,	6	5	Do. 7 p.c. 'C'	11½—12½	...	...
140,778	Stk.	Aug. 9	5	5	Weston-super-Mare Cons. ...	110—112	...	...
64,338	,,	June 21	4	4	Do. 4 p.c. Deb.	96—98	...	...
33,340	,,	,,	7½	7½	Do. 7½ p.c. Deb.	157—160	..	...
LIVERPOOL EXCHANGE.								
157,150	Stk.	Aug. 9	6½	5	Chester 5 p.c. Ord.	104—109	...	...
92,500	,,	June 21	4	4	Do. 4 p.c. Pref.	97—101	...	...
36,430	,,	,,	3½	3½	Do. 3½ p.c. Deb.	89—92	...	...
41,890	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	98—102	...	...
2,167,410	,,	Aug. 23	6	6	Liverpool 5 p.c. Ord. ...	125½—127½	...	...
245,500	,,	June 21	5	5	Do. 5 p.c. Red. Pref. ...	99—104	...	...
306,083	,,	July 1	4	4	Do. 4 p.c. Deb. ...	102—104	...	...
106,280	,,	Aug. 9	10	10	Preston 'A' 10 p.c.	206—216	...	...
188,219	,,	,,	7	7	Do. 'B' 7 p.c.	147—157	..	...
NEWCASTLE EXCHANGE.								
122,577	Stk.	Aug. 9	8	8	Blyth 5 p.c. Ord.	165—166	...	...
732,000	,,	Aug. 9	5	5	Hartlepool G. & W. Co. & New	117—119	...	...
2,061,315	,,	Aug. 9	5⅝	5	Newcastle & Gateshead Con.	22,9—23,3o	- -/6	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	98—100	...	...
776,706	,,	June 21	3½	3½	Do. 3½ p.c. Deb. ...	90½—91½	...	...
277,285	,,	Nov. 1	5	5	Do. 5 p.c. Deb. '43...	103—105	...	...
332,351	,,	Aug. 23	6	6	Sunderland 6 p.c. max. ...	139—141	...	...
NOTTINGHAM EXCHANGE.								
542,270	Stk.	Aug. 9	9	6	Derby Con.	140—150	...	...
55,000	,,	June 7	4	4	Do. 4 p.c. Deb.	100—105	...	...
20,000	10	June 7	5	5	Long Eaton 5 p.c. Pref. ...	10—12	...	...
80,000	Stk.	,,	5	5	Do. 5 p.c. Deb. ...	105—110	...	...
SHEFFIELD EXCHANGE.								
10,000	Stk.	Sept. 20	10	10	Great Grimsby 'A' Ord. ...	210—220	...	...
6,500	,,	,,	10	10	Do. 'B' Ord. ...	210—220	...	...
79,000	,,	,,	10	10	Do. 'C' Ord. ...	205—210	...	...
1,806,339	,,	Aug. 23	6	6½	Sheffield Cons.	144—148	...	...
95,000	,,	July 5	4	4	Do. 4 p.c. Deb.	100—103	...	...
Supplementary List of Stocks and Shares not Officially Quoted								
202,152	Stk.	Sept. 6	25/-b	5	Ascot Ord.	100—105	...	...
128,182	,,	July 5	5	5	Do. 5 p.c. Pref.	108—113	...	...
573,156	1	Nov. 15	5	5	Assd. Gas and Water Ord. ...	19/—21/-*	-/6	...
167,506	1	,,	...	-/4c	Do. 4 p.c. Red. Cum. Pref.	19/—20/-*	...	20/-
253,118	1	,,	...	4	Do. 4 p.c. Irred Pref. ...	18/—20 -*	...	...
500,000	1	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	19/—21/-*	-/6	...
500,000	Stk.	Sept. 6	3½	3½	Do. 3½ p.c. Red. Deb. ...	95—100	...	95½—96
31,035	1	Aug. 23	...	-/4½	Associated Utilities 4 p.c. Pref.	16/6—18/6	...	...
100,000	Stk.	...	...	...	Do. 3½ p.c. Red. Deb.	95—100	...	...
17,000	,,	Aug. 23	8	8	Bognor Orig. Ord. 'A' ...	160—170	...	...
62,210	,,	,,	8	8	Do. New Addl. 'A' ...	160—170	...	...
87,160	,,	,,	7	7	Do. New 7 p.c. max. ...	141—146	...	...
37,440	,,	Aug. 9	10	10	Cam. Univ. & Town 10 p.c.max.	193—203	...	..
125,970	,,	,,	7	7	Do. 7 p.c. max.	135—140	...	...
39,025	,,	,,	5	5	Do. 5 p.c. max.	98—103	...	...
65 000	,,	Aug. 9	8½	7½	Eastbourne 'A' 5 p.c. ...	158—163	...	...
198,000	,,	,,	7	6	Do. 'B' 3½ p.c.	128—133	...	...
112,312	,,	,,	5	5	Do. 5 p.c. Pref.	108—113	...	...
130,000	,,	June 21	5	5	Do. 5 p.c. Deb.	115—120	...	...
24,000	30	Aug. 23	8½	8½	Great Yarmouth 8½ p.c. max.	44—49	...	...
59,400	30	,,	7½	7½	Do. 7½ p.c. max.	34—39	...	...
51,160	Stk.	June 7	5½	5½	Do. 5½ p.c. Deb.	120—125	...	...
152,600	,,	Sept. 6	9	8	Guildford Cons.	170—175	...	..
54,055	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
68,250	,,	June 7	5	5	Do. 5 p.c. Deb.	113—118	...	...
156,600	,,	Aug. 23	7½	7½	Hampton Court Cons. ...	158—163	..	...
73,620	,,	Sept. 6	8½	8½	Luton Cons. 'A'	163—168	...	...
107,960	10	Sept. 20	5½	4	Mid Kent Ord.	8½—9½	...	...
230,940	Stk.	Aug. 9	10	.10	Oxford & District Ord. ...	205—210	...	209—210
47,112	,,	,,	5	5	Do. 5 p.c. Pref.	108—113	...	...
50,000	,,	,,	6	6	Do. 6 p.c. Red. Pref. ...	110—115	...	...
126,193	,,	Nov. 15	7½	7½	Peterborough Ord.	158—163*	-3½	...
64,990	,,	Sept. 6	7½	6½	Redditch Ord.	125—135	...	...
166,850	,,	Aug. 9	8	8	Romford Ord.	155—165	...	...
60,000	,,	,,	4	4	Do. 4 p.c. Pref.	97—100	...	...
44,000	,,	Sept. 20	5	5	Do. 5 p.c. Deb.	113—118	...	...
25,570	,,	Aug. 9	5½	5½	Rugby 5½ p.c. Pref.	125—130	...	...
25,000	,	,,	6	6	Do. 6 p.c. Red. Pref. ...	106—111	...	...
42,750	,,	June 7	5½	5½	Do. 5½ p.c. Deb.	122—127	...	...
10,950	,,	Aug. 23	8	8	Ryde Ord.	158—163	...	...
270,086	,,	Sept. 6	7	7	Slough Ord.	135—140	...	...
21,000	,,	June 21	5	5	Do. 5 p.c. Deb.... ...	112—117	...	...
28,872	1	Nov. 1	5½	5½	S. Midland Gas Cpn. Ltd. Ord.	19/—21/-	...	...
28,866	1	Sept. 6	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	18/6—20 6	...	...
137,730	Stk.	Aug. 9	7	7	Southgate & Dist. 7 p.c. max.	140—145	...	...
62,500	,,	,,	5	5	Do. 5 p.c. Pref.	110—115	...	...
117,228	,,	Aug. 23	5	5	Swindon Cons.	106—111	..	...
60,425	,,	June 7	5	5	Do. 5 p.c. Deb.	110—115	...	...
64,380	,,	June 7	5	5	Torquay and Paignton 5 p.c. Pf	110—115	...	...
500,000	1	Nov. 15	...	- 1 15c	United Kingdom Gas Corpn. 4 p.c. 1st Red. Cum. Pref.	19/—21/-*	...	20/-
130,000	Stk.	Aug. 9	8	5	Wakefield Ord.	120—125	...	...
81,650	,,	,,	5	5	Do. 5 p.c. max.	103—108	...	...
82,000	,,	Aug.	6	6	Weymouth Ord.	103—108	...	...
98,384	,,	Aug. 9	6	6	Wolverhampton 6 p.c. Pref. ...	120—125	...	...
160,000	,,	June 21	5½	5½	Do. 5½ p.c. Rd. Db	108—113	...	...
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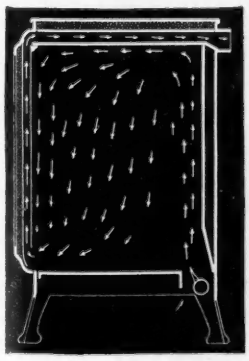

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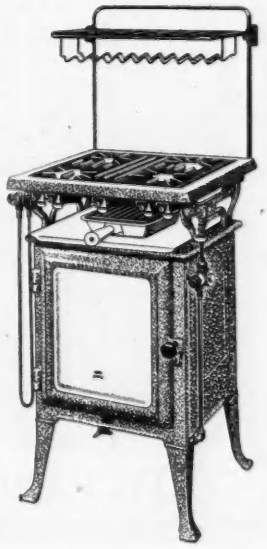

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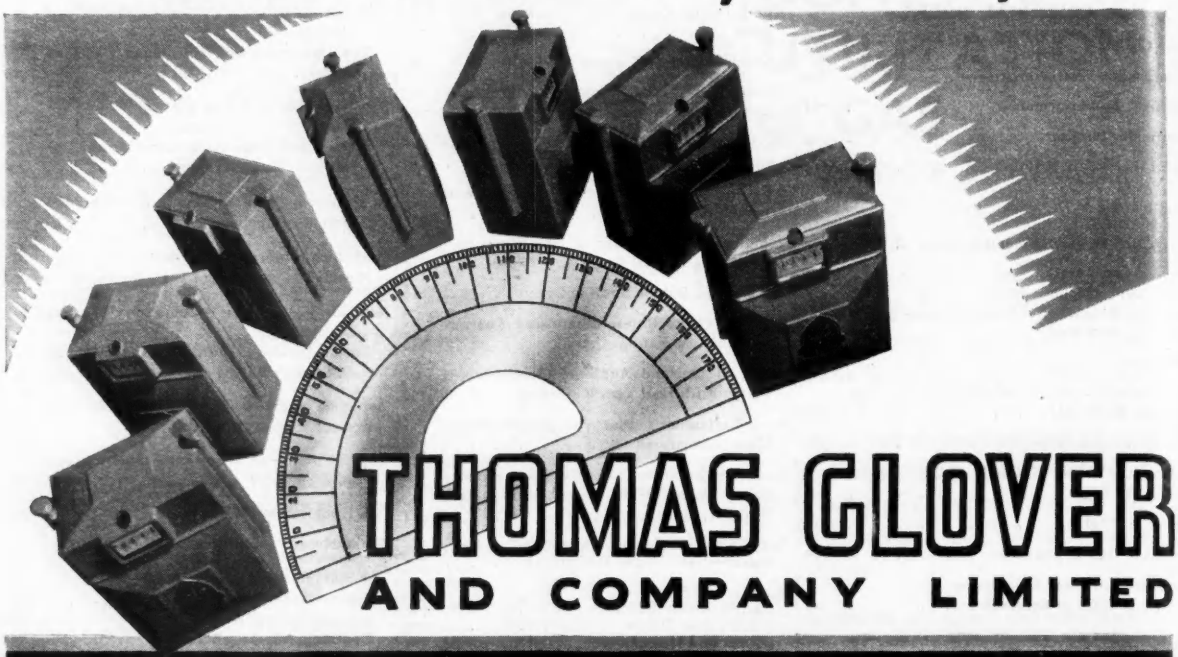

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